

INDOOR AIR QUALITY ACT OF 1988

HEARING
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
OF THE
COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
ONE HUNDREDTH CONGRESS

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WEDNESDAY, SEPTEMBER 28, 1988

HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE
RESEARCH AND ENVIRONMENT
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:30 a.m. in Room 2318, Rayburn House Office Building, the Honorable James H. Scheuer [Chairman of the subcommittee] presiding.

Mr. SCHEUER. Good morning. The Subcommittee on Natural Resources, Agriculture Research and Environment will come to order. This morning, the committee returns to a topic which it first examined over four years ago on which it has spent a great deal of time since then—the important subject of indoor air pollution. I'm going to defer making my statement until after Senator Mitchell has made his. He is on a short timeframe, as we all are in these closing days of the 100th Congress, so why don't I simply say at this point that this is a horrendously important subject, it's really burst upon not only the public consciousness but officialdom in the Executive Branch and EPA and elsewhere as properly a major cause of concern to us; equally and perhaps more important than outdoor air pollution.

So with those words, let me recognize Senator Mitchell for such time as you may need, Senator, to talk about this splendid piece of legislation that you have authored in conjunction with Congressman Kennedy who I presume will be here momentarily.

We are very honored and it's a great pleasure to have you here with us today. Please take such time as you may need.

STATEMENT OF THE HONORABLE SENATOR GEORGE J. MITCHELL FROM THE STATE OF MAINE

Senator MITCHELL. Thank you very much, Mr. Chairman, Ms. Schneider. Good morning. I am pleased to join the other witnesses scheduled.

Mr. SCHEUER. Excuse me just a moment. I didn't hear my colleagues slipping in, but would you join me in deferring our statements until after Senator Mitchell has made his and then we'll make our statements. Okay? Very good.

Senator MITCHELL. I thank you very much, Mr. Chairman and Miss Schneider, for your courtesy. I am pleased to join the other witnesses scheduled to testify today to discuss the health threats posed by contaminants in the air indoors and to review my thoughts on how best to respond to this important problem.

I am pleased that you will also be hearing from Congressman Kennedy. He and I have worked together to develop legislation providing a comprehensive, balanced and affordable approach to protecting the quality of the air indoors.

I first became concerned about indoor air quality several years ago because of a special problem in my home state of Maine. Many Maine homes and buildings have high levels of radon gas. As we all know, radon is not limited to a few states; the EPA estimates that between 5000 and 20,000 Americans die of lung cancer each year attributable to radon, and EPA has called radon a major national health problem.

As we've learned about the seriousness of the radon problem, we've also learned that radon is not the only health-threatening contaminant in the air indoors. Asbestos, combustion byproducts, volatile organic chemicals and tobacco smoke are known to pose significant health threats. The EPA's own research program offers convincing documentation of the health threats posed by indoor air contaminants.

In June of last year, EPA published a major four-volume, multi-year study of total exposure to air pollutants. The report states, and I quote, "The major finding of this study is the observation that personal and indoor exposures to these toxic and carcinogenic chemicals are nearly always greater, often much greater, than outdoor concentrations. We are led to the conclusion that indoor air at home and at work far outweighs outdoor air as a route of exposure to these chemicals."

In hearings on this issue in my Subcommittee on Environmental Protection, witnesses confirmed the general conclusions of the EPA study and agreed that Americans who spend up to 90 percent of the day indoors are exposed to a wide range of contaminants in the air in workplaces, schools, homes and other buildings. That hearing helped convince me that the health threat posed by contaminants in the air indoors is well documented and that it is time to consider legislation to provide a comprehensive framework to address this problem.

In August of last year I introduced legislation authorizing a national program to reduce the threat to human health posed by contaminants in the air indoors. The Indoor Air Quality Act of 1987, which was reported by the Senate Environment Committee in July of this year, has several basic objectives. The bill would expand and strengthen research of indoor air contaminants; it will also assure the development of health advisories on contaminants in the indoor air, including the health risks at a range of concentrations including a "no adverse effect" level. The bill also provides for a national response plan which will focus and direct the relevant authorities which exist in current statutes.

The bill provides no new authority to regulate indoor air contaminants beyond the authorities which also exist in current statutes and regulations. Instead, the bill directs that federal agencies use the response plan to make effective use of the authority in existing statutes.

States have proven to be essential partners in implementing many of our environmental programs. And as you know, Mr. Chairman, the states now administer, to a very large extent, the

existing Clean Air program. I hope this provision of the bill will foster an improved understanding of the role of state governments in responding to indoor air quality programs.

In response to some of the comments from witnesses at our legislative hearing on the bill, we added a section expanding the authority of the National Institute of Occupational Safety and Health to conduct assessments of sick buildings. The bill authorizes expenditures of \$5 million a year for this important effort, and we also added authority for a study of the seriousness and extent of indoor air contamination in our nation's schools, and clarified and strengthened the requirements for public review and comment on various documents provided for in the bill.

I will conclude with two general observations. First, in these days of fiscal constraint, we all must be very conscious of the costs of any legislative proposal. As introduced, the bill included a total authorization of \$58 million a year for five years. As reported by the full committee, the bill provides funding of \$49.5 million a year, a reduction of approximately \$10 million a year. The final cost is proportionate to the seriousness of the problem and the level of expenditure for comparable environmental programs and problems.

And finally, Mr. Chairman and Ms. Schneider, I hope you will question closely the witnesses from the EPA. I expect the EPA will testify against this legislation; that will not surprise you as it did not surprise me, but I find the opposition hard to understand. The EPA's own research program, from which I have directly quoted in this statement, clearly established the seriousness of the health threats, and in an ironic turn of events, the EPA headquarters building itself has indoor air quality problems which have made scores of EPA employees sick. What will it take to get the EPA to take a stand for a comprehensive and coordinated response to a serious and documented pollution problem, rather than offering excuses and reasons for inaction?

I very much look forward to hearing the results of your discussions today and I want to work with you to assure legislation to improve the quality of the air indoors. I'm confident that your efforts will help better define the difficult issues we face in protecting the quality of American air indoors.

Thank you very much, Mr. Chairman, for having me, and again, for your courtesy in permitting me to go forward first.

Mr. SCHEUER. We are delighted to have you, Senator, and it seems to me this is an appropriate courtesy at this time of the year especially as we're rushing to adjournment. We all have agendas that are super-filled.

Senator, both your bill and Congressman Kennedy's bill represent considerable modification from the original version. Could you tell us sort of the evolution of your thinking as these bills have developed, and what are the major differences between the bills as introduced and the bills that we have before us today?

Senator MITCHELL. The modifications really, Mr. Chairman, demonstrate the value of hearings such as this. The bill as introduced didn't include the current provision on sick buildings, and when we got into the hearing and the committee markup process we found a great deal of concern and interest in that area. This is a growing

problem as you know with the increase in the number of buildings that don't have windows that open, that frequently have inadequate ventilation and circulation systems. This first came to my attention in Maine where one of the state government buildings had a very serious problem over many years. And so a principal change is to include the authorization to conduct assessments of sick buildings.

A second change was to add authority to determine the extent of the problem in the nation's schools. It's obviously a serious matter for all Americans. We're especially concerned about any adverse health effect on our children, of course.

And finally, we reduced the amount of money involved from the \$58 million as originally introduced by almost \$10 million to try to make it more acceptable to those who would otherwise oppose the bill. I would say those are some of the major changes in the bill and the reasons for them, Mr. Chairman.

Mr. SCHEUER. Thank you, Senator.

Do you think in consideration of air pollution in the workplace and air pollution at homes in residential settings we ought to have the same standards, the same levels of acceptable risk, or should we differentiate between air pollution in the home and air pollution at the workplace?

Senator MITCHELL. I think, Mr. Chairman, that there is a valid basis for distinguishing between exposures in the workplace and in residential settings. First, most persons are in the workplace for a maximum of around 40 or slightly more hours a week, and as a result, the amount of exposure is not nearly equal to the amount of time a person spends in the home.

Secondly, many people—

Mr. SCHEUER. You're suggesting there that perhaps the standards of acceptable pollution at home should be higher and risk should be reduced at least on a per hour exposure point of view.

Senator MITCHELL. That's right. I think we have to take into account the amount of time people spend in the various settings.

And secondly, Mr. Chairman, I'd just make another small point that many workplaces are not nearly as small and confining as our residences. Large office buildings such as this one here, and there's greater possibility for circulation, ventilation and dilution.

Mr. SCHEUER. Do you think that EPA's experience with asbestos and radon could serve and should serve as models for an indoor air quality program?

Senator MITCHELL. Certainly, Mr. Chairman, I would say so with respect to radon. I, as Chairman of the Senate Subcommittee on Environmental Protection, have had many sharp disagreements with the EPA on a wide range of issues. But I must say that on radon, it was an exemplary working relationship, and while I am critical of the EPA for opposing this bill, I think fairness dictates that I say that on radon they were forthcoming, they were interested in dealing with the problem; and as a result we passed a radon bill in the Senate, and I hope we're going to see comparable action in the House in these closing few weeks. So yes, Mr. Chairman, I would say that the experience with respect to radon can and hopefully will serve as a model with respect to indoor air generally.

Mr. SCHEUER. I think fairness would also require me to say that this subcommittee has had four hearings in the last four years on indoor air pollution including the first congressional consideration of radon, and there is no member of Congress in either the House or the Senate who has played a more persistent, nudging, urging, cajoling, probing role in this quest to identify the level of risk with radon and come up with acceptable solutions than my colleague, Claudine Schneider of Rhode Island. She has been a tremendous bird dog and a tremendous goad in this area, and she is due a great deal of credit. She has really won the admiration of all of us for the persistence and thoughtfulness in which she has pressed this issue. And I'm going to yield to her if she wants to add any other comments for the role that not only she played, but we played together, in all seriousness.

We did pull and drag them kicking and screaming into this whole radon area, and I'm delighted that from your perspective at least they've been cooperating so well and working so diligently and thoughtfully. That's all to the good and I congratulate them, too.

Ms. Schneider?

Ms. SCHNEIDER. Thank you, Mr. Chairman, and I thank you for your most generous comments, and recognizing of course that—

Mr. SCHEUER. You wouldn't say I overdid it at all, would you?

Ms. SCHNEIDER. No.

Mr. SCHEUER. I understated your contribution.

Ms. SCHNEIDER. Needless to say, without two to tango here, we would not have been successful in moving this legislation through and bringing it to national attention over the last couple of years.

But Senator Mitchell, I would like to get a few comments on the record since you are the first witness, and we'll have the opportunity to talk to EPA a little bit later. It seems to me that perhaps one of the greatest objections that I am anticipating that EPA will have is that of the budget. I believe our indoor air research budget right now runs somewhere \$2 and \$3 million, and your suggestion is for the expenditure of \$58 million. And what concerns me is that even though this is election time, I think there will be a grappling with reality of our deficit next year, too, and I'm just wondering do we take some of those monies you're suggesting that we spend for indoor air pollution from other environmental programs, or where do we get the money?

Senator MITCHELL. Let me first cite to you the EPA's own words, its own current set of priorities, and then ask you to make that judgment. Here is what the EPA said of the relative significance of exposure in the outdoors and indoors. I quote the EPA:

"The major finding of this study is the observation that personal and indoor exposure to these toxics and carcinogenic chemicals are nearly always greater, often much greater, than outdoor concentrations. We are led to the conclusion that indoor air in the home and at work far outweighs outdoor air as a route of exposure to these chemicals." That's the EPA's report.

Now, what is the EPA doing? They are spending \$300 million a year on programs for the protection of outdoor air, and they oppose spending \$49 million a year for protection of indoor air, even

though their own study demonstrates that the indoor air is far more of a serious problem.

By no standard of logic or common sense or discharge of our public responsibilities to protect the health of Americans can that disparity be justified. And I frankly think we should do both. And I don't think it's too much to ask that the EPA devote some attention to dealing with what it states is a very serious health problem.

So one of the problems here, Ms. Schneider and Mr. Chairman, is that over the years the use of the word "environment" has come to many Americans to be the functional equivalent of natural resources—forests, lakes, oceans, visibility. In our advanced industrial society what we are now seeing is that protection of the environment is much more a personal health problem. If every American understood that what we're talking about here is their health and especially the health of their children, when we talk about these problems, I think there would be a much greater public demand for this kind of action.

Ms. SCHNEIDER. Well, that certainly sets out the philosophy, and I think that we know, who have been deeply involved in this issue, that it is a problem and it has to be one of our first primary environmental challenges that we undertake. But we still don't answer the question where we get the money.

Senator MITCHELL. Well, I think it should come out of the EPA's budget, and if need be, they'll find the place for it. It's \$49 million a year in a multi-billion dollar budget. And if need be, if it's necessary, we should increase the amount of funding allocated to them.

Let me tell you this. The EPA budget today is in real dollars at the same level it was eight years ago, and—

Ms. SCHNEIDER. Yes, and that was a travesty. So since you are the Chairman of the Senate Committee, I just wondered if you felt that it was realistic to increase the budget. I mean, under your leadership on the Senate side, you feel that you're going to be able to get this kind of increase through?

Senator MITCHELL. Yes. Let me say that we have opposed in our committee on a bipartisan basis—this is not Democrats versus Republicans, in our committee we have opposed on a bipartisan basis the efforts by the Administration to render the EPA wholly ineffective over recent years.

Now, the fact is that we have made cuts, and what has happened—and we know this is not just in the EPA, but the Administration comes in and proposes these massive reductions. We are able to moderate the cuts, so we cut a little bit, and we think we've won a victory, when in fact they've really won a victory by setting the terms of the debate as being, first, whether we're going to have these massive cuts as proposed. You've been through that here so you know exactly what I'm talking about.

But the reality is that although the population of this country has increased dramatically in the past 10 years, the number of motor vehicles registered has almost doubled, the number of motor vehicle miles driven has almost doubled, the discharge of contaminants into the air and water has increased, and the responsibilities of the EPA have increased, the EPA's capability to deal with it has been reduced. And so what we've got to do is get it back to the

level they need, and I say if we need \$49 million a year to protect the health of Americans indoors, we ought to do so.

And I'll make one final point on this because you've touched on what is really the heart of the issue. The Administration has proposed cuts in the EPA while they have proposed tremendous increases in other areas of the budget, as you well know. And so it's a matter of priorities, what is or is not important. I think the health of American children, the health of American families, the confidence of being safe and secure in their own homes ought to be a relevant and important factor in our consideration.

Ms. SCHNEIDER. Well, Mr. Mitchell, I agree with you completely but you just used the words yourself, the Administration proposed, and I think in fairness to all parties, you know what we say around here that the President proposes and Congress disposes. And despite the fact that we have had bipartisan effort on many environmental fronts, we have seen those cuts take place, so it's not that we were impotent in that process, we being the members of Congress.

Senator MITCHELL. I'll just say to that, Ms. Schneider, though, nothing becomes law without the President's signature.

Ms. SCHNEIDER. This is true.

Senator MITCHELL. It has become fashionable for members of the Executive Branch to say we can't spend a penny without the Congress approving it, but nothing becomes law without the President's signature or the President's veto being overridden.

Ms. SCHNEIDER. I have a question on standards. I was wondering about the idea of why not having a standard in the health advisories where the comparison would be the level of contamination outside to the level of contamination inside? Is that something that your committee has reviewed?

Senator MITCHELL. Yes, we did, and we decided against the establishment of standards. Standards, as you know, connote and are in fact a specific standard requiring enforcement or calling for enforcement, and we felt that was too big a step to take at this early stage; that we're best off getting health advisories—that is, really providing the American people with information on which they can make judgments as to what is or is not safe and what can or cannot be done. So this is a modest first step; it does not require standards that would be enforceable.

Ms. SCHNEIDER. But setting levels, where you call for no health effects levels, isn't that the same as a standard?

Senator MITCHELL. No, because it's not enforceable. It's information as opposed to compelling action.

Ms. SCHNEIDER. I see. I don't have any further questions, Mr. Chairman. Thank you.

Mr. SCHEUER. Thank you, Ms. Schneider, and thank you very much, Senator. You have certainly dramatically and eloquently outlined the problem, that as our knowledge of the enormity of indoor air pollution and other pollutants that affect the health and safety of Americans goes up, the tools which the Administration is ready to accept from Congress goes down. It's a bizarre relationship.

And as you know, in terms of research, in real dollars the research dollars that we have today are 40 percent less than the re-

search dollars that we had in real terms when this Administration came in. They have gutted the research capability. Twenty percent of the scientists have left EPA in disgust, including some of the very most talented. And that has been the legacy that you have very brilliantly described.

Well let me thank you for your testimony. We look forward to working with you on this matter, and we hope that great things are going to happen as a result of this in terms of the living quality of Americans in the indoor environment. And we hope that next year, no matter what the results of the first Tuesday in November's events may be, that we will have an administration that is far more keenly attuned, sensitively attuned, to the dramatic level of crisis that has come to our environment both outdoor and indoor, and the urgent wish of all Americans to do something about it.

There hasn't been a single poll of the American people that hasn't indicated that both across political lines, cultural lines, geographic lines, all lines, Americans want to spend whatever has to be spent to assure a safe and a healthy environment. And you have played a magnificent role on the Senate side, and we congratulate you for that, and we thank you for coming here this morning.

Senator MITCHELL. Mr. Chairman, thank you again, and I also want to express my gratitude to you and Ms. Schneider for your work on radon and in other areas, and I hope very much that we can duplicate here what we've been doing there. Thank you very much.

Mr. SCHEUER. Thank you.

I wish to modestly amend a statement I made about EPA being dragged kicking and screaming into concern with radon. It really wasn't the EPA, it was the Office of Management and Budget. Year after year for three or four years, the EPA wanted the resources to face up to this matter, and they didn't get it; it was OMB that cut them off at the knees. And I wish to make that clear; the EPA was there, ready, concerned, willing to go to work at all times.

Thank you very much, Senator.

Let's get on with the opening statements that Ms. Schneider and I have to make, and by that time Congressman Kennedy, who is on the way, should be here.

As came out of the discussion, four years ago there was very little knowledge about the indoor air pollution problem; indeed, then many of our colleagues were skeptical that such a problem even existed. And I was just mentioning, OMB was routinely axing EPA's requests for modest funds to study the problem.

Of course, a great deal has happened in the last four years and now we know that radon is the second leading cause of lung cancer after cigarette smoking, claiming between 5000 and 20,000 cancer deaths every year. The risks of second-hand cigarette smoke, formaldehyde, asbestos have become well known. And the federal government, the states, and many localities have led the way in programs that remove asbestos, restrict smoking and ban formaldehyde based installations.

Indeed, since 1984, we have learned from EPA's multi-disciplinary, multi-year research studies that personal exposure in the

home to pollutants is far more hazardous than exposure from living in highly industrialized areas. Some of the implicated air contaminants include volatile organic chemicals emitting from such sources as smoke from cigarettes, wood stoves and fireplaces; dry cleaned clothes; ironically, showers that spew into the air radon, formaldehyde and other pollutants; and ironically also, so-called air fresheners, air fresheners that actually pollute the very air that they are described as freshening.

In 1986, just two years ago, this committee, with the great leadership of our ranking Republic colleague, Claudine Schneider, drafted Title IV of the Superfund Amendments and Reauthorization Act, so-called SARA, and we provided the first legislative direction for EPA's indoor research activities. Under that law, EPA is scheduled to provide a report to Congress next month, and of course we will be inquiring about the status of that report later today when we hear the EPA witnesses.

And in 1987, just a year ago, a report by top EPA scientists concluded that indoor air pollution was likely to be more dangerous than most other environmental problems that EPA is regulating, including all the toxic waste sites, 10,000 of them, that constitute the Superfund mission, so to speak. Imagine that. Indoor air pollution provides more of a threat to Americans than all of the toxic waste sites in this country that have been identified so far, put together. Yet, as EPA itself has admitted, the amount of money that it spends on indoor air pollution is only a tiny fraction of the amount it spends on toxic waste.

So the time has come to recognize indoor air pollution as the serious public health threat that it truly is. It's an invisible and insidious epidemic. While an expanded research program must continue to provide the basis for moving ahead, it's clear that it's time to go beyond research.

And the bill that's before the subcommittee today, H.R. 5373 authored by Congressman Joe Kennedy of Massachusetts, the Indoor Air Quality Act of 1988, sets out a proposal for a new, non-regulatory indoor air program for the EPA.

While we obviously can't finish work on this bill in the less than two weeks that—about two weeks that remain in the 100th Congress, at least this day's hearings will provide us with the background we need to work on this bill so that we hit the deck running early in the 101st Congress.

We have already heard from Senator Mitchell, Congressman Kennedy, and we'll hear from you directly after any remarks that my colleague, Ms. Schneider, wishes to make.

Ms. SCHNEIDER. Thank you, Mr. Chairman. In the interest of time, I will give an abbreviated version of my statement because I notice we have quite a long list of witnesses here today. But I did want to mention a couple of different principles, three principles that I believe are rather basic to the successful indoor air program, and I hope that Congressman Kennedy will address these principles and we can have a clearer understanding as to what direction the bill will take us.

First of all, policy recommendations I believe should be based on sound scientific information; thus, the need for improving the research budget is certainly necessary. Secondly, I think that re-

search should develop solutions as well as identify problems. And thirdly, the guidelines for actions should be made clear and quite certain. I think that this has been some of the difficulty that we have had in the pilot project.

My own state of Rhode Island was one of those 10 states that had the opportunity to do some internal testing. There we found 21 percent of the homes had exceeded the limit of four picocuries, so of course this raises great concerns for all of us.

I think that overall, the legislation that we are talking about really does need to focus on the whole question of no health effects standards—excuse me, I'll remove that word standards—no health effects and to get a better idea as to what we can hope to realize as a result of this legislation.

Thank you, Mr. Chairman.

Mr. SCHEUER. Very good. Congressman Kennedy, why don't you come and take such time as you may need to elaborate your concerns and the provisions of your bill.

STATEMENT OF THE HONORABLE JOSEPH P. KENNEDY, REPRESENTATIVE IN THE U.S. CONGRESS FROM THE 8TH DISTRICT OF MASSACHUSETTS

Mr. KENNEDY. First of all, let me thank the Chairman and members of the committee for their interest in this important issue, and the fact that you were willing to hold hearings on this issue this year is very, very much appreciated.

Mr. SCHEUER. As you know, we've had four hearings on this issue of indoor air pollution, including the first hearing on radon several years ago. And I, and especially Claudine Schneider, have been deeply concerned, and we've been trying to bring the Administration and the EPA into some kind of consciousness of the importance of indoor air pollution. And I must say in all candor that EPA has been on the qui vive, they have been at the cutting edge, they have wanted to do the work but year after year after year, the Office of Management and Budget has absolutely ravaged their research budgets for indoor air pollution.

And it wasn't until we got the language of our bill, Ms. Schneider and myself, into the Superfund bill that finally OMB was forced to unleash EPA to do the research on indoor air pollution that they really wanted to do. So it's in that environment that we welcome you here today, and we welcome your bill.

Mr. KENNEDY. I appreciate that all the much more, Mr. Chairman, because I know that you and Ms. Schneider have really been on the leading edge in trying to get action by the government taken on this issue.

It seems that the recent publicity which has created quite a stir—I know that in the state of Rhode Island and Massachusetts and a whole range of other states around the country that this has caused tremendous anxiety amongst millions of Americans. And for this committee to have taken those stands so early, for the EPA to have taken the stand I think is just another indication of where the priorities of what's going on at 1600 Pennsylvania Avenue are.

But the fact is that we can do something about the problem at the moment, and this is a step in that direction, but we've got to do more than I think even this bill at this point would involve.

Mr. Chairman, thank you for this opportunity to discuss the merits of the legislation addressing a serious threat to the health of our nation; the contamination of our indoor air. Take a deep breath. The air you just inhaled probably passes through several hundred feet of dark, dusty ductwork before it reaches us; 26 species of fungus, many of them capable of causing serious illness have been found growing in the dank recesses of ventilation systems in buildings all across this country. These airborne viruses and bacteria can cause flu, pneumonia, tuberculosis and other respiratory ailments. Do you want me to go on, Mr. Chairman? Do you want me to issue the gas masks now or—

[laughter.]

Mr. SCHEUER. You can go on but I'm going to stop breathing while you do it.

Mr. KENNEDY. As one example, the Associate Press reports this week that seven people have died of Legionnaire's disease at the UCLA Medical Center in a nearby nursing home. They were among an estimated 45,000 cases of Legionnaire's Disease in this country every year caused by a virus that breeds in air ducts. This is a disease that could be controlled and possibly eliminated with improved clean air technology.

Beyond those living bacterial dangers, indoor air can also contain large doses of carbon dioxide, carbon monoxide, formaldehyde, asbestos and other substances that can be dangerous to our health. There are examples everywhere. 170 workers have sued Lockheed Corporation because they are getting sick from working on the Stealth Bomber. They are breathing dust from sanding and inhaling chemicals that they cannot even name. Lockheed refuses to admit they are building the Stealth Bomber, let alone that it is making their workers sick.

Radon gas has been on everyone's mind lately. The EPA has recently announced that one in five of all American homes contains dangerous quantities of radon, and in some areas 60 percent of those homes present serious health risks to their owners. A recent Army study revealed that soldiers stationed in modern, air conditioned barracks suffered 45 percent more respiratory ailments than those living in drafty, older barracks, open to the air. Clean ventilation is clearly important to a healthy indoor life.

Employees of—

Mr. SCHEUER. That's a really astonishing statistic you're giving us. It's really mind boggling. Maybe we shouldn't build anymore new barracks for the Army.

[Laughter.]

Mr. KENNEDY. I don't know as you'd want to live in every one of those old barracks, at least at Otis Air Force Base.

Mr. SCHEUER. Well, I lived on one more than—about 45 years ago in Biloxi, Mississippi, and it was called Pneumonia Gulch. But I guess it was safer than the new barracks in 1988.

Mr. KENNEDY. That's right, which is Legionnaire's Gulch.

Employees right here at an EPA building right down the street in our nation's capitol recently took to the streets to protest the

quality of the air inside. Some employees have become seriously ill as a result of the building materials such as carpet glue that were used inside that building.

The right of Americans to breathe clean air does not end the moment they walk indoors. 90 percent of Americans are exposed day after day to indoor contaminants that both the EPA and the scientific community identify as serious health risks.

The Indoor air Quality Act of 1988 is intended to meet our responsibility to protect Americans from unseen dangers in the air they breathe every day. The bill addresses the problem of indoor air quality in non-industrial workplaces, public and commercial buildings and homes, by establishing an Office of Indoor Air Quality within the EPA.

This legislation provides a program of research and development concerning the extent and effects of contamination and includes an agenda for reducing those risks. In addition, the legislation promotes effective application of clean air technology by federal and state governments and the private sector.

The bill includes a special section calling for the assessment of contaminants in "sick buildings" or modern buildings that are chronically subject to indoor air pollution. There is a provision that deals specifically with indoor air pollution problems in public schools and day care facilities. In particular, for schools and day care providers there is a program for testing and the reduction of radon gas.

This legislation will also set up five regional training centers for state and local officials to learn about testing and remediation of radon gas concentration. States have a role to play as well, and this proposal allocates \$12 million for grants to states that would develop their own response to deal with the indoor air quality. The other body has already acted on this legislation, and it has been marked up in full committee. This version of the Act incorporates the constructive work that has been done to improve the legislation since its original introduction late last year.

I invite my colleagues to join me in sponsoring this bill, and I hope that the House can act quickly and effectively to improve the quality of the air we breathe.

I commend you, Mr. Chairman, and the members of this committee for the work that you've done on this whole issue and hope that we can work together in the future.

Mr. SCHEUER. Well thank you very much, Senator Kennedy—excuse me, Congressman Kennedy.

Mr. KENNEDY. Teddy would not be pleased there.

Mr. SCHEUER. Well, Teddy would be honored by the quality act that you put on here. You've shown imagination and drive and initiative, and you're certainly going to be part of this overall team on the House side that is going to produce some legislation. And I congratulate you for the imagination and leadership, as I say, with which you have prosecuted this matter.

No questions. Thank you very much for testifying and we'll be in touch with you as our plans develop.

Mr. KENNEDY. Thank you very much, sir.

Mr. SCHEUER. Oh, excuse me, Congressman Tom McMillen of Maryland, one of the really great new members on this committee

who has really positively affected the quality and the quantity of the work that we're doing.

Mr. McMILLEN. I think the Chairman didn't notice me because I was sitting down, possibly.

[laughter.]

I'm just curious as to the cost of this. I wasn't here earlier on, Joe, if you could maybe go through. You mentioned a \$12 million state grant?

Mr. KENNEDY. That's right. Tom, basically through the bill itself we set up—first of all, what we have to do is research and identify what the contaminants are. That provision in the bill would cost about \$18 million. The state response plans, the Office of Indoor Air Quality at the EPA and the like would cost about \$12 million. The total cost of the bill would be somewhere around \$59 million.

The one thing about indoor air pollution, as the Chairman just mentioned, it isn't a very difficult problem to fix once we identify exactly what the problem is. Essentially what you have are buildings that are too tight, and where the air that is breathed is recirculated so many times that the contaminants that are in the building become so concentrated that it becomes extremely damaging. Obviously, in many cases all you have to do is set up a little fan in the window to take some of the air out, or open up the in-duct vents on the roofs of many buildings to include more outside air.

But there should be specific guidelines set up and there should be studies done to indicate what the extent of the damage already is, so the benefit of the bill is not highly expensive. But we can create tremendous savings by the avoided health care costs.

Mr. McMILLEN. So it's \$18 on the R&D, \$12 on the states and then there's some other extra costs—I'm just curious.

Mr. KENNEDY. Excuse me, it's \$49.5 million total, not \$59.

Mr. McMILLEN. And that's analogous to the Senate bill, too, that's exactly what the costs are.

Mr. KENNEDY. That's right.

Mr. McMILLEN. Good. Thank you.

Mr. KENNEDY. Thank you.

Ms. SCHNEIDER. I'll interject one more question. Can you elaborate a little bit about the schools, and if they provide a unique challenge for us in this area?

Mr. KENNEDY. Obviously, as you are so well aware, Ms. Schneider, with work that you've done in your own state on this issue, the fact is that the radon, particularly the radon problem, is particularly difficult in schools and with younger children in day care centers. You know, it's one thing if those of us maybe 40 or 50 years old end up being exposed to cancer-causing agents. It's another thing for very young children to be exposed to those who have long lives potentially to live, and obviously have tremendously more to lose due to early exposure.

The other thing is it's so easy to fix this problem. I mean, even in the cases that you've outlined where the number of picocuries is extremely high, the fact is that for a \$25 expenditure we can go in, we can test and then we can just circulate the air in those buildings and get rid of it. So this is not a difficult problem to fix. It's important that we do it for our children, though.

Mr. SCHEUER. Thank you very, very much, Congressman Kennedy, you've really made a great contribution and we'll be working with you in the months to come.

Mr. KENNEDY. Look forward to it. Thank you very much.

Mr. SCHEUER. We have a roll call vote on now so we're going to suspend for about 12 or 13 minutes.

[Recess.]

Mr. SCHEUER. We will ask Mr. Clay to take his seat. Donald Clay, Acting Assistant Administrator of the Office of Air and Radiation of the Environmental Protection Agency.

Mr. Clay, why don't you take such time as you may need, perhaps in the neighborhood of seven or eight minutes, to tell us how EPA perceives the problem, what you're doing about it, what additional funding and legislative authority you might like to have, and in general bring us up to scratch on your plans and prospects.

**STATEMENT OF DON CLAY, ACTING ASSISTANT ADMINISTRATOR,
OFFICE OF AIR AND RADIATION, ENVIRONMENTAL PROTECTION AGENCY**

Mr. CLAY. Thank you, Mr. Chairman. With your permission then I'll put my full statement in the record and have a few brief opening remarks.

Mr. SCHEUER. Without objection, so ordered.

Mr. CLAY. Thank you. It has been some time since the last House hearing on indoor air and a great deal has transpired on the issue and I'd like to bring you up to date on what's going on at EPA. As you know, EPA's total exposure studies have demonstrated that levels of many pollutants indoor often exceed outdoor concentrations by two to five times. Couple that with the length of time people spend indoors, we believe that indoor air pollution represents a significant portion of the public's exposure to air pollution, much as you said in your own opening statement.

We have seen a major increase in the instance of problem buildings where occupants experience immediate short-term health effects which can be caused by a variety of factors including biological and chemical pollutants. Of course, in the last three years radon has become a major issue as we learn more about the nature of the problem. EPA recently announced the results of a seven-state survey adding to the ten we had already done and recommended that all homeowners and those that live in first and second-story apartments have their homes tested for radon.

The radon program has taken a non-regulatory approach to a high risk problem, emphasizing problem assessment, mitigation and prevention and the development of a partnership with state and local government and significant public information efforts to alert the public to both the potential problems and ways to mitigate it.

In many way, we see the radon problem as a viable model for addressing the broader issues of indoor air quality with which we are just beginning to come to grips. But like radon, other residual indoor air problems are difficult to regulate, particularly when problems are due to choices which individuals make about their own lifestyles; for example, choosing to smoke in their own homes.

We believe that people will generally make the wisest choice if we can provide them with the information on environmental risk, and most importantly, practical and economical steps which they can take to reduce those risks.

Getting information out to the public in fact is one of the top priorities for our indoor air program. We've just sent to the printer a 32-page pamphlet of everything you want to know about indoor air—one like this, and we'd be happy to provide one for the record if you'd like—as well as a list, a directory of state indoor air contacts that we've just gotten back from the printer.

We're also developing a series of fact sheets on indoor air issues and have two more technical manuals in preparation on mitigation of environmental tobacco smoke and prevention of indoor air quality problems in buildings. At the same time, there are currently situations where regulations are both necessary and appropriate to deal with indoor air. We are addressing the asbestos exposure indoors under the Asbestos School Hazard Abatement Act and the Asbestos Hazards Emergency Response Act.

We also have active chemical control programs under both the Toxic Substances Control Act and FIFRA, which have addressed indoor air exposures which we will continue to use for that purpose when we think a regulatory solution is the best solution.

Other agencies that also have authorities can be brought to bear on the indoor air problem—the Consumer Product Safety Commission for example has jurisdiction over products such as kerosene heaters that may contribute to indoor air problems. At this point in time, we are actively pursuing research and policy development goals to try to address the many unanswered questions concerning the sources, health effects and control of indoor air pollution and the most appropriate federal role in mitigating risk to the public.

On the research front, we are actually developing models in monitoring techniques, conducting health effects research on indoor air pollutants, and beginning to look at mitigation measures.

Within the Office of Air and Radiation we have an active indoor air program, which incidentally we just elevated to the status of a division as part of a reorganization of the office it's in, which is responsible for developing the information and materials, coordinating the many EPA and federal indoor air activities, assessing the appropriate federal role in indoor air quality, and establishing policy priorities for the research program. We have actively stepped up our coordination efforts and have a number of cooperative projects underway with other federal agencies such as the Indoor Air Quality Booklet which was joint with CPSC, and the Kerosene Heater Research Book with Consumer Product Safety Commission.

We also believe that the CIAQ is a much more effective coordinating body than it used to be and have attempted to make the meetings more substantive and useful to member agencies.

Let me turn briefly then to H.R. 5373, the legislation introduced last week by Congressman Kennedy. We think that the work that has been done on the bill in the past year represents significant improvements in many areas. Nevertheless, we do not believe that H.R. 5373 provides us with any additional authority to conduct re-

search and disseminate information other than is currently provided under SARA Title IV.

In getting to the many policy issues which must be addressed before we are able to fully determine the appropriate long-term federal role, we have discovered that coming to a firm consensus will require substantially more information than is currently available or which we've been able to digest. For example, is the private sector capable of providing indoor air quality diagnostic and mitigation services to the public? Should there be governor oversight of these contractors? How significant is the sick building problem in the country? And who is best able to address the problem?

In addition, we believe that the authorization levels are significantly higher than can be efficiently utilized at this time. We are also not convinced that the health advisory approach is necessarily the best approach to communicating health risk information to the public, and are also concerned with the zero risk implications of focusing a national response plan on the achievement of no effect levels.

Despite the problems we have with the bill there are some potentially useful provisions including the information clearinghouse to make information available on the scientific and policy issues as well as mitigation techniques.

In conclusion then, despite improvements to the original version of S. 1629, we believe that the existing SARA Title IV contains sufficient authority to carry on an effective research and information dissemination program. We are making progress on indoor air pollution and are committed to continue that effort in the future and look forward to a continuing constructive dialogue with this committee as it continues its deliberations.

I'd like to conclude and answer any questions you have, Mr. Chairman.

[The prepared statement of Mr. Clay follows:]



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OCT 18

OFFICE OF
AIR AND RADIATION

Honorable James H. Scheuer
Chairman, Subcommittee on Natural Resources,
Agriculture Research, and the Environment
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington DC 20515

Dear Mr. Scheuer:

At the September 28 hearing on indoor air legislation, you requested any information that the U.S. Environmental Protection Agency might currently have to offer to architects who are seeking advice in how to design buildings for maximum indoor air quality. As I indicated to you, EPA has identified architects as one of the most important audiences for the public information materials that EPA will produce under Title IV of the 1986 Superfund Amendments and Reauthorization Act. A manual on the prevention of indoor air quality problems targeted particularly at architects, engineers, and building owners is in preparation and is currently scheduled for completion in the spring of 1989.

We have two current publications that give some instruction to architects and others concerned about indoor air quality in new buildings:

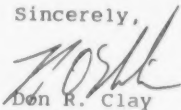
- o The EPA booklet entitled Radon Reduction in New Construction: An Interim Guide gives home builders and home owners information on construction methods that will minimize radon entry into homes and that will facilitate radon removal after construction, if radon levels are found to be high.
- o In the booklet for the general public, The Inside Story: A Guide to Indoor Air Quality, there is a section on new homes that mentions several actions that builders and home owners can take to prevent indoor air quality problems. This booklet is at the printer and due to be released by early November.

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I am also enclosing a paper, "Protocols to Improve Indoor Environmental Quality in New Construction," that was delivered at the 1987 American Society of Heating, Refrigerating, and Air-Conditioning Engineers Conference on Indoor Air Quality. The paper was written by Hal Levin, the architect whom EPA has hired to advise the Agency on the design of its new headquarters building.

We appreciated the opportunity to testify before the Subcommittee on Natural Resources, Agriculture Research, and the Environment on September 28th. We look forward to working with you and your staff as indoor air quality legislation is developed in the future.

Sincerely,


Don R. Clay
for Acting Assistant Administrator

Enclosures

1

STATEMENT
OF DON R. CLAY
ACTING ASSISTANT ADMINISTRATOR
OFFICE OF AIR AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
OF THE
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

SEPTEMBER 28, 1988

Good Morning. My name is Don Clay, Acting Assistant Administrator for the Office of Air and Radiation at EPA. It's a pleasure to be here this morning to discuss with you the progress we are making in addressing indoor air quality issues and to comment on the legislation pending before this Subcommittee. Before I offer our thoughts on the legislation, I'd like to provide you with a sense of EPA's past involvement in indoor air quality issues, what we have learned from some of our current indoor air related programs, and some of the things we are doing to build an effective response to what is emerging as a major environmental issue.

In 1983, when Congress first established the Interagency Committee on Indoor Air Quality -- or CIAQ -- EPA's research program began to share information with a number of other Federal agencies with an interest in indoor air quality. At that time, EPA's Total Exposure Assessment Methodology -- or TEAM -- studies were documenting what many had suspected for some time: for many pollutants, indoor concentrations often exceed ambient, or outdoor levels. In 1984, although no explicit legislative authority for EPA's indoor air activities existed, EPA began to conduct research into indoor air quality problems.

By October 1986, when Title IV of the Superfund Amendments and Reauthorization Act

(SARA) was signed into law, a number of significant program initiatives were underway to address specific pollutants which had been identified as posing substantial long term risks to segments of the U.S. population.

The Asbestos Technical Assistance Program, initiated in 1979, was merged into the Asbestos Action Program after the Asbestos School Hazard Abatement Act (ASHAA) was passed in 1985 and is responsible for reducing indoor exposure to asbestos. This program provides a wide range of technical assistance services to States, building owners and managers, asbestos abatement contractors, and the public. In addition, the Agency's asbestos program administers the school loan and grant program under ASHAA and has established a comprehensive framework of regulatory standards for managing asbestos in schools under the Asbestos Hazards Emergency Response Act (AHERA). Most recently, EPA submitted its Report to Congress on Asbestos-Containing Materials in Public and Commercial Buildings.

The Agency's Radon Action Program is another major program aimed at reducing human health risks resulting from indoor exposure to a significant naturally-occurring environmental pollutant. In contrast to the asbestos program, which relies to a large extent on a large grant component and a regulatory strategy, our radon program is primarily non-regulatory in nature. Comprised of four complementary elements -- problem assessment, mitigation and prevention, capability development, and public information -- the radon program has made significant progress in a relatively short time frame in alerting the public to both the risks of radon exposure as well as the options for testing and mitigation where elevated levels of radon are found. With the Public Health Service, we are stressing the synergistic risk with smoking and the necessity for smoking cessation and prevention.

At the same time, a number of indoor air related activities have been underway in other offices throughout the agency. The Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the Safe Drinking Water Act all provide the Agency

with useful tools for addressing aspects of indoor air exposures. Under TSCA, we are actively addressing consumer exposure to solvents as part of a major integrated workgroup on chlorinated solvents in which other Federal agencies as well as affected industries are participating. Under FIFRA, we have banned the use of lindane as an indoor fumigant and the recent voluntary cancellation of chlordane for use as a termiticide are both good examples of our ability to control individual chemicals that pose unreasonable risks to health through indoor exposures. One example of continuing research into the issue of indoor residential pesticide exposure is the current Non-Occupational Pesticide Exposure Study (NOPES), a cooperative effort between our Office of Pesticides Programs and Office of Research and Development.

Despite the tools that are currently available to us to address aspects of the indoor air problem, we began to recognize in 1986 that a chemical-by-chemical approach to indoor air pollution problems was not going to be sufficient to solve the problem. At that time, we were beginning to see a significant increase in occupant complaints in many modern office buildings, many of which were associated with inadequate ventilation. In addition, we began to see data indicating that major classes of indoor air pollutants -- including biological contaminants, environmental tobacco smoke, and low levels of volatile organic compounds -- were not being addressed at all from a programmatic standpoint. As a result, in 1986 we created an indoor air staff whose functions are to provide a policy framework for the EPA indoor air research program, begin to develop an EPA indoor air quality policy, to disseminate information to a broad spectrum of audiences in need of information on indoor air quality, and to coordinate the many indoor air activities underway at EPA with on-going activities in Federal, State and local governments and in the private sector.

Last June, EPA submitted its Indoor Air Quality Implementation plan to Congress. Among other things, this plan outlined our overall strategy for addressing indoor air quality problems. The first element of this strategy is to begin, through an active research program, to fill the

many gaps in our knowledge about the exposures and health effects resulting from indoor air pollutants and ways to reduce risks to human health. The second element of the strategy is to continue to vigorously exercise our existing regulatory authorities under TSCA, FIFRA, the Safe Drinking Water Act (SDWA) and other appropriate legislative tools. Finally, we will continue to utilize non-regulatory programs as appropriate to address indoor air quality problems. As we have learned from the radon effort, non-regulatory programs are sometimes the most effective approach to solving indoor air quality problems. These activities include building effective partnerships with other Federal agencies, the States, local governments, and the private sector and disseminating information on indoor air risks and risk reduction strategies.

EPA is actively implementing this strategy. EPA's indoor air research program has made significant contributions to our understanding of indoor air exposures and methods to reduce those exposures. For example, using small test chambers, we have developed protocols for testing the emissions from different building materials. Our monitoring research includes compiling a compendium of indoor air quality measurement methods. EPA health effects research has completed an assessment of the effects of acute exposures to nitrogen dioxide on pulmonary function. Our exposure assessment and risk characterization research has enabled us to prepare an indoor air information assessment which was submitted to Congress last June as part of EPA's Indoor Air Implementation Plan.

In addition to the already developed asbestos, radon, and chemical control programs under TSCA and FIFRA, our major thrust is to focus on information dissemination, coordination, and policy development. A major priority has been to begin to disseminate the information we have developed on indoor air quality through our research program and other sources. A booklet for the general public on indoor air quality has just been sent to the printer and will be available next month. The booklet, titled The Inside Story: A Guide to Indoor Air Quality, was jointly produced with the Consumer Product Safety Commission and we think it will have a

substantial impact in educating consumers to both the risks of indoor air pollution and more importantly, practical steps individuals can take to reduce those risks. We have also just completed a comprehensive directory of state agency contacts on 16 different indoor air quality issues. This directory, which was developed by the Public Health Foundation as part of a cooperative agreement with EPA, should go a long way toward providing the public with sources of assistance on issues of concern, no matter what agency of state government has the responsibility for managing that issue.

While I'm touching on the coordination aspect, I'd like to discuss what I think are major improvements in the operation of the Interagency Committee on Indoor Air Quality (CIAQ). In the last 6-9 months, the CIAQ has completed a reevaluation and restructuring designed to improve the coordination of Federal indoor air quality programs. We prepared and widely distributed a detailed 44 page guide to Current Federal Indoor Air Quality Activities, including a brief description, status, and contact point for more than 500 different indoor air projects now underway. The quarterly meetings of the CIAQ are also more substantive than in the past, incorporating speakers and presentations on key technical and policy issues of interest to Federal indoor air quality representatives.

On the policy front, we have begun to identify and explore some of the policy options for addressing the very broad and complex issues posed by indoor air pollution. We expect to complete several analyses in the near future dealing with the adequacy of existing voluntary standards and guidelines developed by non-governmental bodies for addressing indoor air quality problems, the economic impacts and known risks from indoor air pollutants, and the existing statutory authority for effectively dealing with the various indoor air pollution issues.

Despite the significant progress we are making in addressing indoor air quality problems, we recognize that we are only beginning to adequately characterize the extent of the problem and develop -- in concert with other Federal agencies and departments -- an

appropriate Federal response. H.R. 5373 would dramatically expand the Federal response to indoor air pollution. As you know, H.R. 5373 is a companion bill to S. 1629, introduced by Senator Mitchell last year. While improvements have been made to the Mitchell Bill and incorporated into H.R. 5373 which address at least some of our concerns with new indoor air quality legislation, we have several concerns which prevent the Agency from supporting the bill.

Our first concern is with the timing of the bill. SARA Title IV specifically requires that EPA, among other things, evaluate the appropriate Federal role in indoor air quality and make recommendations. Until such time as we are able to complete analysis of the adequacy of existing regulatory and other authorities for dealing with indoor air pollution, we would be reluctant to endorse legislation of any sort.

One of our primary concerns with H.R. 5373 is the very large authorization level which would throw huge sums of money at the problem, almost overnight. Overall, we still believe that while the current risk data indicate that a significant research and information program should be conducted, the authorization levels are significantly higher than necessary or appropriate.

With respect to the research provisions, we would prefer to retain more flexibility than is provided to establish policy relevant priorities for the research program rather than the detailed and prescriptive research requirements contained in H.R. 5373. We support changes to the research provisions that increase the emphasis on identification of sensitive populations, assessment of indoor air quality problems in schools, and the impacts of indoor air quality on workers in non-industrial settings. Nevertheless, we do not believe that the research provisions are necessary since our current research authority under Title IV is very broad.

We continue to be concerned about aspects of the Health Advisory provisions of both bills.

Of particular concern is the practicality and utility of establishing a list of contaminants that may be found in indoor air without basing that list on the existence of the contaminant *at levels that may pose widespread health risks*. A more fundamental problem is the desirability of sending the agency down a track where we are attempting to "pick off" indoor air pollutants one by one when multi-pollutant strategies may prove more effective in the long run in communicating risks and risk mitigation information to the public. On the surface, it is difficult to argue with the premise that government should provide individuals with the best information available on contaminants that may pose widespread health risks. Before the Federal government embarks on a course which commits it to publishing advisory after advisory on individual pollutants, however, it is important to recognize that the public will only benefit from such information if: 1) the health effects and exposure data is based on sound and sufficient science; 2) there are affordable monitoring devices that will allow the public to determine the levels that are present in their indoor environment; 3) there are effective and affordable measures available to the public to reduce their exposures to the pollutant; and 4) there is consistency across various levels of government in the advice provided.

Unfortunately, for the vast majority of indoor air pollutants, we are not yet at a stage where these conditions can be met. Furthermore, we are concerned by the underlying premise in the health advisory provision that we should be emphasizing a zero risk approach to environmental protection by focusing our national response plan strictly on achievement of a safe or no effect level, even if attainment of that level is not technologically achievable.

Because of the building-by-building nature of the indoor air problem, we believe that significant involvement by State and local governments will be necessary in addressing any identified indoor air quality problems. At the same time, we believe that we are not far enough along in characterizing the problem to warrant even a limited grant program.

I'd like to address myself for a moment to some of the new provisions of H.R. 5373 which

we believe are potentially useful provisions. The Federal Building Response Plan in H.R. 5373 appropriately places responsibility for Federal buildings primarily with GSA, with EPA playing a strong consulting and supporting role. However, GSA should not be singled out from all other Federal agencies which control buildings, schools, and housing. In many instances, it is in schools and housing where the real health risks may be encountered such as radon and asbestos.

As we at EPA have learned first hand in recent months, an effective program to assess and mitigate identified indoor air quality problems in Federal buildings is needed. We feel strongly that we need to begin to make building owners and managers in both the public and private sectors more aware and knowledgeable about indoor air quality problems and preventive and corrective measures which can be implemented. GSA has taken the first step in this direction by developing a draft program to assess indoor air quality and address indoor air complaints in buildings under their jurisdiction.

Although no new legislation is necessary, we wholeheartedly endorse the proposal that EPA design, operate, and maintain our new headquarters building as a model of indoor air quality. We have already begun to implement this provision by retaining an architect who is a recognized national expert in planning for indoor air quality to help us develop the technical facility requirements that may be used by GSA to solicit proposals for the new EPA headquarters building.

In conclusion, despite some improvements to the original version of S. 1629, we believe that the existing SARA Title IV contains sufficient authority to carry out an effective research and information dissemination program. We are making progress on indoor air pollution and we are committed to continuing that effort in the future. We look forward to a constructive dialogue with this committee as it continues its deliberations on H.R. 5373. Thank you.

Mr. SCHEUER. Thank you very much, Mr. Clay. Section 5(c) of Congressman Kennedy's bill sets out a technology demonstration program similar to that carried out by EPA under Superfund. Are technologies being developed for controlling indoor air pollution that would be eligible for demonstration under this section? Is federal funding necessary to ensure the successful commercialization of such technologies?

Mr. CLAY. Some are being developed. The question is—we believe we already have the authority, though, to develop the technologies, although we think that would be a useful provision of the bill.

Mr. SCHEUER. You already have the authority.

Mr. CLAY. We believe so, yes.

Mr. SCHEUER. Do you think you have existing statutory authority under Title IV of SARA, the Superfund bill, or any other laws to issue health advisories and response plans as envisioned by Congressman Kennedy's bill? In other words, would a new law provide EPA with a clearer congressional mandate in this direction?

Mr. CLAY. I think it would probably be a clearer congressional mandate but we think we have the authority under the Information Dissemination sections of SARA Title IV. And of course under the Toxic Substances Control Act we've been putting out health advisories with no complete authority, no clear statutory authority.

Mr. SCHEUER. What is the current status of the EPA report on indoor air quality programs that are required under Title IV of Superfund?

Mr. CLAY. That's the report that's due the end of October; we're working very hard on it. We have early drafts. We'll probably not make the October 31st date but we're working very hard on it and we have early drafts now and we expect to have it up here in the fall.

Mr. SCHEUER. If you won't make October 31st what are you likely to make?

Mr. CLAY. Before the end of the year.

Mr. SCHEUER. All right. To what extent should your experience, EPA's experience, with asbestos and radon serve as models for an indoor air quality program?

Mr. CLAY. I think the radon experience is particularly relevant here. Here you have a non-regulatory approach to a serious indoor air problem itself. I think the kind of experience we've had in getting certification programs involving the state and local people, providing information so people can make decisions is very relevant. Asbestos somewhat so, but that's more of a regulatory program and is a little different in nature.

Mr. SCHEUER. The National Indoor Air Quality Response Plan was intended to develop methods to reduce exposure to indoor contaminants to levels at which, as they say, there is no known or anticipated human health effect with an adequate margin of safety. Is this a reasonable goal? Can we achieve it without inordinate expenditures? And how does this goal compare with the "remedial action", the remedial action level EPA has published in the case of radon?

Mr. CLAY. Well, they're somewhat similar in that they're both non-standards, as you pointed out earlier, and they are not regulatory requirements. The radon action level, though, is something

that is probably easier to achieve because we can measure cheaply for it. It's very difficult to measure, as you know, for many of the indoor air contaminants. So the fact that you had the information out there doesn't mean that people are going to be capable of using it. You're providing information and certainly no one is against people making informed choices, but to have a "no effect level" out there with no way of measuring what you have we don't think is nearly as useful as having the radon, something you can easily measure.

Mr. SCHEUER. Mr. Clay, since we got started in this whole area of indoor air pollution some four years ago, and we've had three or four hearings in the meantime, four, I've been contacted by various groups on the outside, government groups and private groups and so forth, as to whatever guidelines do you have. How can you help us? Do you have a list of do's and don'ts that would guide us? And I've gotten these kind of requests from architects, from various standard-setting organizations, from builders, from building owners and operators, from engineers, from labor unions, from building material manufacturers. They all want to know how they can do right.

Do you have in any one publication or any one document a sort of list of guidelines of do's and don'ts that would apply to let's say new government buildings, office buildings, schools, hospitals, commercial buildings, department stores, private apartment houses, hotels. And of course residences, high rise and low rise.

Mr. CLAY. One of the things we have in the works and we plan for the publication next spring is a manual for architects and building owners. That's something we're working on. We recognize the need there and are doing that.

Mr. SCHEUER. And engineers, of course. Architects and engineers.

Mr. CLAY. Yes.

Mr. SCHEUER. Would this be in relationship to radon or all of the indoor air pollutants?

Mr. CLAY. Could be all the indoor air pollutants.

Mr. SCHEUER. I wonder if you could give this committee in the next week or so whatever data you have accrued so that we can publish it in our report and then as we get further requests we can say EPA is going to publish a manual next spring but in the meantime, here is their thinking. There are lots of government agencies out there that are approving plans for new buildings, new projects, residential, commercial, government office buildings, private office buildings, that would like whatever help we can give them now.

Mr. CLAY. We would be pleased to do so, Mr. Chairman.

Mr. SCHEUER. That would be very, very useful.

[The material referred to follows:]

United States
Environmental Protection
Agency

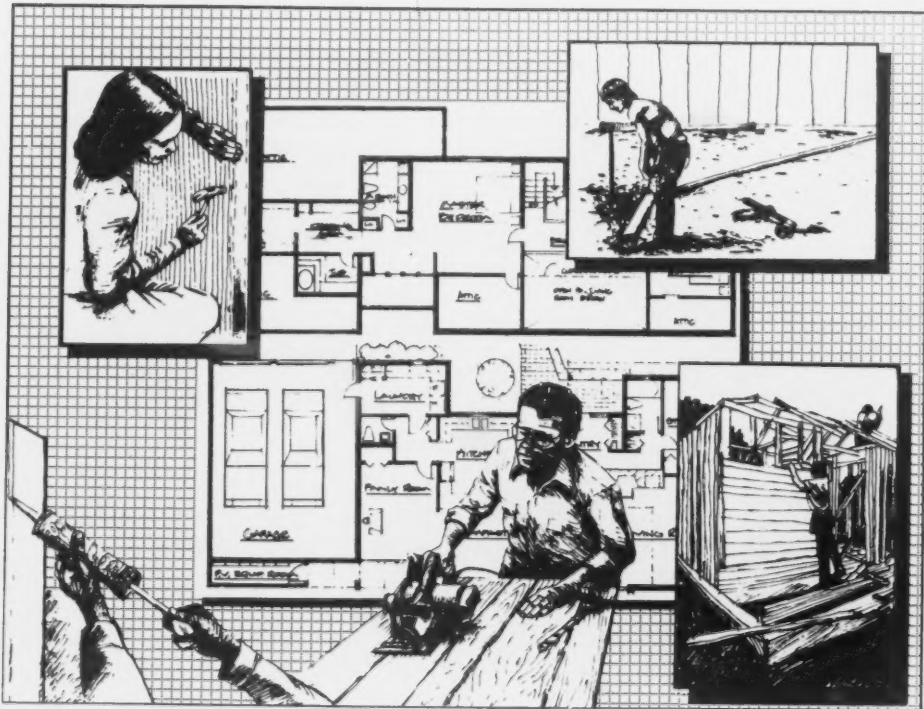
Offices of
Air and Radiation and
Research and Development
Washington DC 20460

August 1987
OPA-87-009



Radon Reduction in New Construction

An Interim Guide



Introduction

The U.S. Environmental Protection Agency (EPA) is concerned about the increased risk of developing lung cancer faced by persons exposed to radon in their homes. Because many families already face the problem, early emphasis was placed on identifying the danger in existing homes and developing cost-effective methods to make such housing safer. Based on this early research, EPA published three documents in 1986: *A Citizen's Guide to Radon: What It Is and What To Do About It*, *Radon Reduction Methods: A Homeowner's Guide*, and a more detailed manual, *Radon Reduction Techniques for Detached Houses: Technical Guidance*. These documents were designed to help homeowners determine if they have a radon problem and to present information on how to reduce elevated radon levels in their homes.

This pamphlet is the next step in attempting to reduce the radon hazard in homes. It is designed to provide radon information for those involved in new construction and to introduce methods that can be used during construction to minimize radon entry and facilitate its removal after construction is complete. If there is concern about the potential for elevated indoor radon levels, it may be prudent to use these construction techniques in new homes. The "Techniques for Site Evaluation" section of this pamphlet outlines several methods for assessing the potential for elevated indoor radon levels. The decision to incorporate these construction techniques rests solely with the builder or homeowner.

In addition to extensive internal EPA review, this pamphlet has been developed in coordination with the National Association of Home Builders Research Foundation, Inc. (NAHB-RF) a not for profit organization, and other federal agencies including the Department of Energy (DOE), Housing and Urban Development (HUD), United States Geological Survey (USGS), and the National Bureau of Standards (NBS). It also reflects comments solicited from a broad spectrum of individual experts in home construction and related industries.

It is potentially more cost-effective to build a home that resists radon

entry than to remedy a radon problem after construction. The construction methods suggested in this pamphlet represent current knowledge and experience gained primarily from radon reduction tests and demonstrations on existing homes. Field tests are underway to develop and refine the most cost-effective new-home construction techniques. After completion of these field tests, a more detailed "Technical Guidance" manual will be published to expand and revise, as necessary, the interim guidance presented in this pamphlet. Accordingly, this *Interim Guide* should not be referenced in codes and standards documents.

Radon Facts

Radon is a colorless, odorless, tasteless, radioactive gas that occurs naturally in soil gas, underground water, and outdoor air. It exists at various levels throughout the United States. Prolonged exposure to elevated concentrations of radon decay products has been associated with increases in the risk of lung cancer. An elevated concentration is defined as being at or above the EPA suggested guidelines of 4 pCi/l or 0.02 WL average annual exposure.* Although exposures below this level do present some risk of lung cancer, reductions to lower levels may be difficult, and sometimes impossible to achieve.

Soil gas entering homes through exposed soil in crawl spaces, through cracks and openings in slab-on-grade floors, and through below-grade walls and floors is the primary source of elevated radon levels (Figure 1). Radon in outside air is diluted to such low concentrations that it does not present a health hazard. In some small public and private well-water supplies, radon is a hazard primarily to the extent that it contributes to indoor radon gas concentrations. When water is heated and agitated (aerated), as in a shower or washing machine, it will give off small** quantities of radon.

Radon moves through the small spaces that exist in all soils. The speed of movement depends on the permeability of the soil and the presence of a driving force caused when the pressure inside a home is lower than the pressure outside or in

the surrounding and underlying soil. A lower pressure inside a home may result from:

- Heated air rising, which causes a stack effect.
 - Wind blowing past a home, which causes a down-wind draft or Venturi effect.
 - Air being used by fireplaces and wood stoves, which causes a vacuum effect.
 - Air being vented to the outside by clothes dryers and exhaust fans in bathrooms, kitchens, or attics, which also causes a vacuum effect.
- In homes, where a partial vacuum exists, outdoor air and soil gas are driven into the home.

New Construction Principles

The facts just discussed form the basis for the following new-construction principles:

- Homes should be designed and constructed to minimize pathways for soil gas to enter.
- Homes should be designed and built to maintain a neutral pressure differential between indoors and outdoors.
- Features can also be incorporated during construction that will facilitate radon removal after completion of the home if prevention techniques prove to be inadequate.

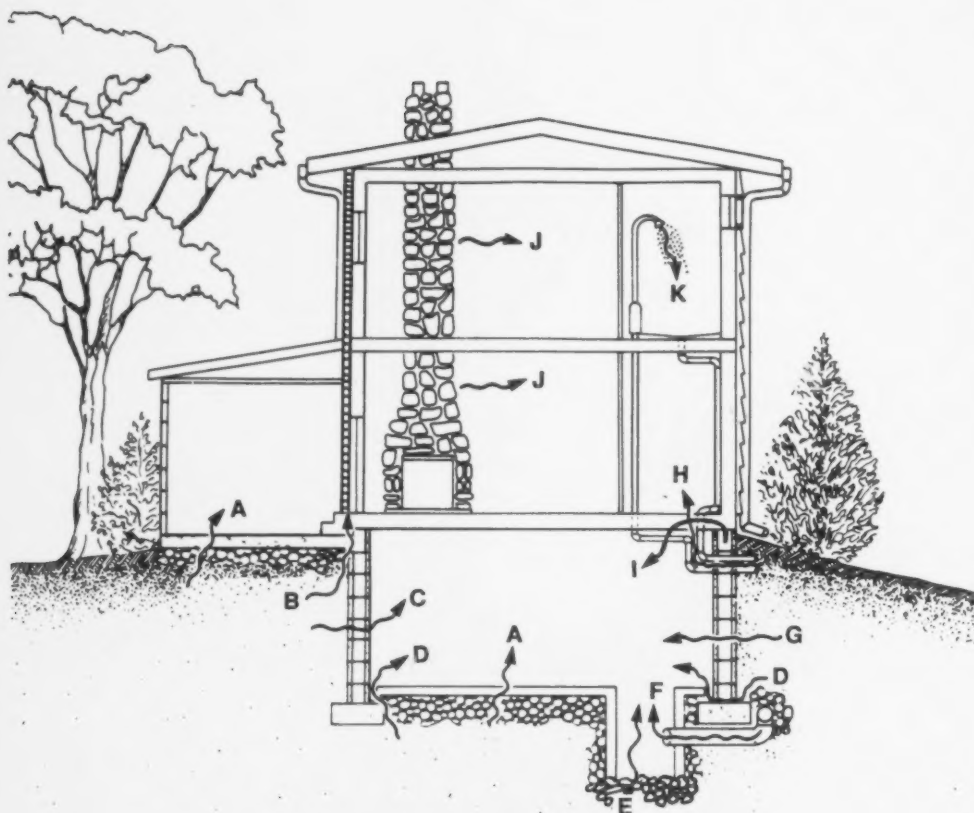
The following techniques for site evaluation and construction are based on these principles.

Techniques for Site Evaluation

The first step in building new radon-resistant homes is to determine, to the degree possible, the potential for radon problems at the building site. At this time, there are no standard soil tests or specific

* pCi/l, the abbreviation for pico Curies per liter, is used as a radiation unit of measure for radon. The prefix "pico" means a multiplication factor of 1 trillionth. A Curie is a commonly used measurement of radioactivity. WL, the abbreviation for Working Level, is used as a radiation unit of measure for the decay products of radon. The relationship between the two terms is generally $200 \text{ pCi/l} = 1 \text{ WL}$.

** The generally accepted rule of thumb for emanation of radon gas from water is: 10,000 pCi/l of radon in water will normally produce a concentration of about 1 pCi/l of radon in indoor air.



MAJOR RADON ENTRY ROUTES

- A. Cracks in concrete slabs
- B. Spaces behind brick veneer walls that rest on uncapped hollow-block foundation
- C. Pores and cracks in concrete blocks
- D. Floor-wall joints
- E. Exposed soil, as in a sump
- F. Weeping (drain) tile, if drained to open sump
- G. Mortar joints
- H. Loose fitting pipe penetrations
- I. Open tops of block walls
- J. Building materials such as some rock
- K. Water (from some wells)

Figure 1

standards for correlating the results of soil tests at a building site with subsequent indoor radon levels. The variety of geological conditions in the United States will probably continue to preclude establishment of any all-inclusive, nationwide standards for such correlation. We can, however, estimate the radon potential at a building site based on factors other than soil tests. If the answer to any of the following questions is yes, radon problems might be anticipated and radon reduction features should be considered for inclusion in construction plans.

- Have existing homes in the same geologic area experienced elevated radon levels? ("Same geologic area" is defined as an area having similar rock and soil composition characteristics.) State or regional EPA offices may be able to assist in obtaining this information.

- What are the general characteristics of the soil? State and local geological or agricultural offices can normally help in providing answers to the following questions on soil:

- Is the soil derived from underlying rock that normally contains above-average concentrations of uranium or radium, e.g., some granites, black shales, phosphates or phosphate limestones?
- Is the permeability of the soil and underlying rock conducive to the flow of radon gas? Note that soil permeability (influenced by grain size, porosity, and moisture content) and the degree to which underlying and adjacent rock structures are stable or fractured can significantly affect the amount of radon that can flow toward and into a home.

- If the source of water to the site is going to be a local or onsite well, have excessive levels of radon been detected in other wells within the same geologic area? (Levels measured above 40,000 pCi/l of water could alone produce indoor radon concentrations of about 4 pCi/l or above. Such levels are considered excessive.) State or local health agencies, departments of natural resources, or environmental protection offices may be able to assist in providing this information. Testing well water for radon before the home is built could provide an additional indication of a potential radon problem. If excessive radon levels are confirmed, a granular activated-carbon

filtration system or an aeration system might be designed into the plumbing plan.

Construction Techniques

Some of the radon prevention techniques discussed below are common building practices in many areas and, in any case, are less costly if accomplished during construction. Costs to retrofit existing homes with the same features would be significantly higher. Although these construction techniques do not require any fundamental changes in building design, there is a continuing need for quality control, supervision, and more careful attention to certain construction details. Construction techniques for minimizing radon entry can be grouped into two basic categories:

- Methods to reduce pathways for radon entry.

- Methods to reduce the vacuum effect of a home on surrounding and underlying soil.

Typically, the techniques in both categories are used in conjunction with each other.

Methods to Reduce Pathways for Radon Entry (Figure 2)

In Basement and Slab-on-Grade Construction:

- Place a 6-mil polyethylene vapor barrier under the slab. Overlap joints in the barrier 12 inches. Penetrations of the barrier by plumbing should be sealed or taped, and care should be taken to avoid puncturing the barrier when pouring the slab.
- To minimize shrinkage and cracks in slabs, use recommended water content in concrete mix and keep the slab covered and damp for several days after the pour.
- To help reduce major floor cracks, ensure that steel reinforcing mesh, if used, is imbedded in (and not under) the slab. Reducing major cracks in footings, block foundation, and poured-concrete walls will reduce the rate of radon entry. Radon can, however, enter homes through even the smallest of cracks in concrete slabs and walls if a driving pressure is applied to those surfaces.
- The most common radon-entry pathways are inside perimeter

floor/wall joints and any control joints between separately poured slab sections. To reduce radon entry through these joints, install a common flexible expansion joint material around the perimeter of the slab and between any slab sections. After the slab has cured for several days, remove or depress the top 1/2 inch or so of this material and fill the gap with a good quality, non-cracking polyurethane or similar caulk. Similar techniques for sealing these joints may also be used.

- In some areas, basement slabs are poured with a French Drain channel around the slab perimeter. To be effective, this moisture control technique requires that the floor/wall joint be open to permit water to seep out into the sub-slab area. To reduce radon entry through such open joints, it may be necessary to install a perforated drain pipe loop under the slab, adjacent to the footing and imbedded in aggregate, and to tie this pipe into a sub-slab ventilation system to draw radon gas away from the French Drain joint (Figure 4). For additional information on water control techniques, refer to National Association of Home Builders (NAHB) publication *Basement Water Leakage: Causes, Prevention, and Correction*.

- When building slab-on-grade homes in warm climates, pour the foundation and slab as a single (monolithic) unit. If properly insulated below grade-level, shallow foundations and slabs can also be poured as a single unit in cold climates.

- Remove all grade stakes and screed boards and fill the holes as the slab is being finished. This will prevent future radon pathways through the slab, which might otherwise be created as imbedded wood eventually deteriorates.

- Carefully seal around all pipes and wires penetrating the slab, paying particular attention to bathtub, shower, and toilet openings around traps.

- Floor drains, if installed, should drain to daylight, a sewer, or to a sump with pump discharge. Floor drains should not be drained into a sump if such a pit will be used as part of a sub-slab ventilation system.

Suction on the sump could be defeated by an open line to the floor drain.

- Sumps should be sealed at the top. In closed sumps used for sub-slab

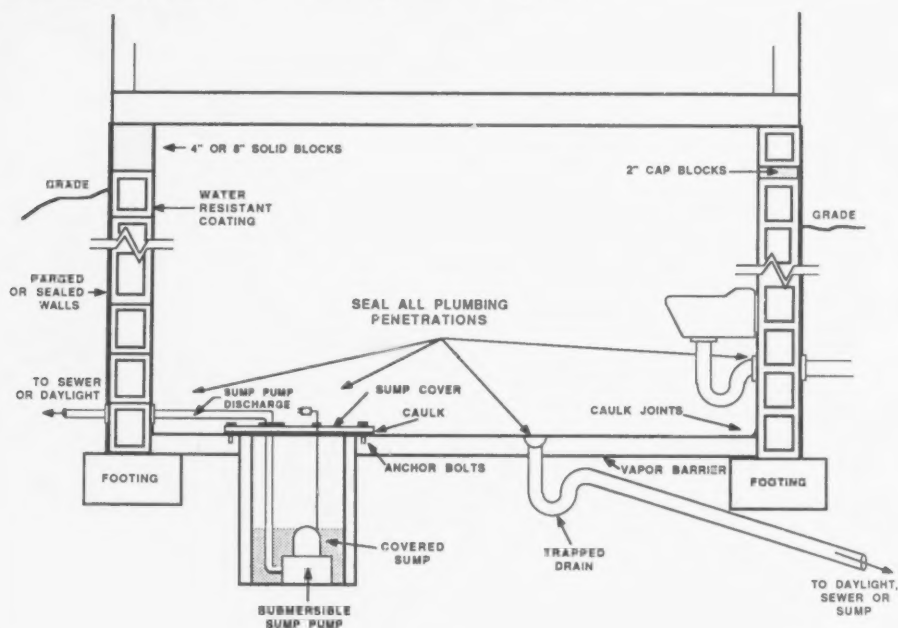
ventilation systems, the continuous flow of moist air through the sump can cause rapid corrosion of exposed sump pump motors. For this reason, submersible-type sump pumps are recommended for closed-sump applications.

In Basement and Crawl space Construction:

- Seal or cap the tops of hollow-block foundation walls using one of the techniques shown in Figure 2.
- Carefully seal around any pipe or wire penetrations of below-grade walls.
- Exterior block walls should be parged and coated with high-quality vapor/water sealants or polyethylene films. For additional information on wall sealing, refer to NAHB publication *Basement Water Leakage: Causes, Prevention, and Correction*. Several new products for use on exterior walls are designed to provide an airway for soil gas to reach the surface outside the wall rather than being drawn through the wall. Similar materials may also be used in sub-slab ventilation applications.
- Interior surfaces of masonry foundations may be covered with a high-quality, water-resistant coating.
- Heating or air-conditioning ductwork that must be routed through a crawl space or beneath a slab should be properly taped or sealed. This is particularly important for return air ducting, which is under negative pressure. Due to difficulty in achieving permanent sealing of such

ductwork, it may be advisable to redesign heating and ventilating systems to avoid ducting through sub-slab or crawl space areas, particularly in areas where elevated soil radon levels have been confirmed.

- Install air-tight seals on any doors or other openings between basements and adjoining crawl spaces.
- Seal around any ducting, pipe, or wire penetrations of walls between basements and adjoining crawl spaces, and close any openings between floor joists over the dividing wall.
- Place a 6-mil polyethylene vapor barrier on the soil in the crawl space. Use a 12-inch overlap and seal the seams between barrier sections. Seal edges to foundation walls.



METHODS TO REDUCE PATHWAYS FOR RADON ENTRY

Figure 2

Methods to Reduce the Vacuum Effect (Figure 3)

- Ensure that vents are installed in crawl space walls and are sized and located in accordance with local building practices. Adequate ventilation of crawl spaces is the best defense against radon entry in crawl space-type homes.
- Reduce air flow from the crawl space into living areas by closing and sealing any openings and penetrations of the floor over the crawlspace.
- To reduce the stack effect, close thermal bypasses such as spaces around chimney flues and plumbing chases. Attic access stairs should also be closed and sealed. (Note: Because of potential heat buildup, most codes prohibit insulating around recessed ceiling lights. Such lights should therefore be avoided in top-floor ceilings. As an alternative, use recessed ceiling lights designed to permit insulation or "hi-hat" covers and seal to minimize air leakage.)
- Install ducting to provide an external air supply for fireplace combustion.
- In areas frequently exposed to above-average winds, install extra weather sealing above the soil line to reduce depressurization caused by the Venturi effect. Such sealing will also save energy and reduce the stack effect.
- Air-to-air heat exchange systems are designed to increase ventilation and improve indoor air quality. They may also be adjusted to help neutralize any imbalance between indoor and outdoor air pressure and thus reduce the stack effect of the home. They should not, however, be relied upon as a stand-alone solution to radon reduction in new construction. (A slightly positive pressure, in the basement, may contribute to reducing radon flow into a home.)

Construction Methods That Will Facilitate Post-Construction Radon Removal (Figure 4)

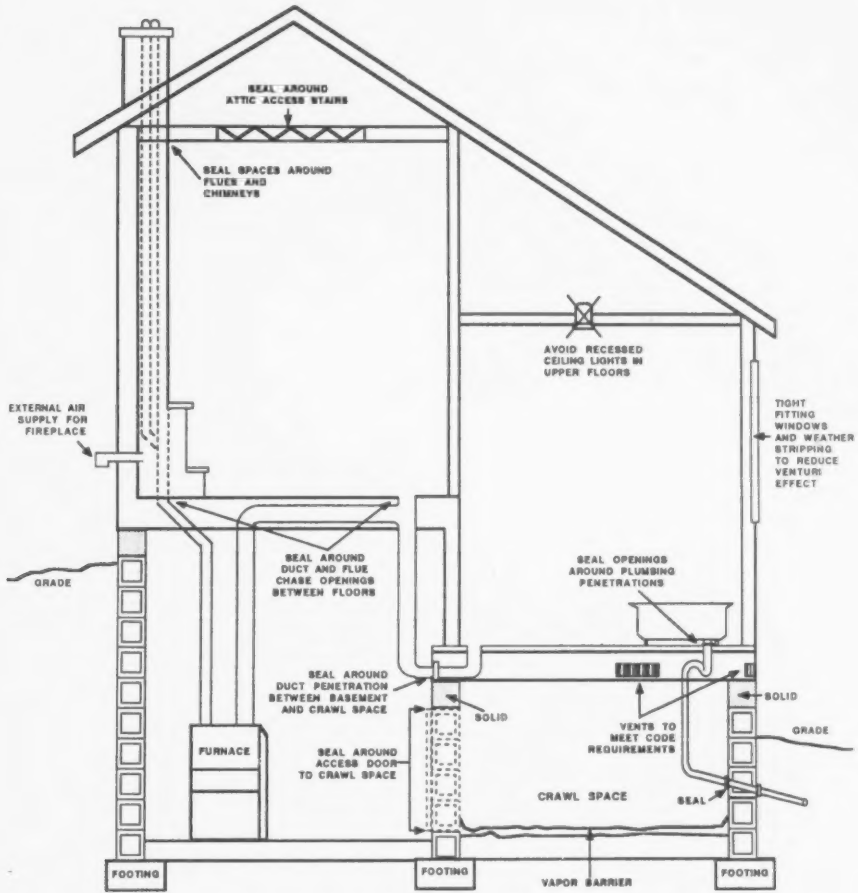
Recognizing that radon prevention techniques may not always result in radon levels below the suggested guideline of 4 pCi/l average annual exposure, there are several additional construction techniques that can be used to facilitate any post-construction radon removal that may be required.

- Before pouring a slab, fill the entire sub-floor area with a layer (4 inches thick) of pea gravel or larger, clean aggregate to facilitate installation of a sub-slab ventilation system.
- Lay a continuous loop of perforated 4-inch diameter drain pipe around the inside perimeter of the foundation footing. Run the vent from this loop into the side of a closed sump that can, if necessary, be equipped with a fan-driven vent to the outside. In this configuration, the drain pipe loop can aid in water seepage control as well as radon reduction.
- As an alternative to the vented interior drain pipe loop, a similarly vented exterior loop can be laid outside the foundation footing.
- In areas where water seepage into below-grade spaces is not a problem and sump pumps are not installed, exterior or interior drain pipe loops can be stubbed-up outside the home or through the slab and can be available for use as sub-slab ventilation points if needed.
- The soil beneath a slab can also be ventilated using the following technique: Prior to pouring the slab, insert (in a vertical position) one or more short (12-inch) lengths of 4-inch minimum diameter PVC pipe into the sub-slab aggregate and cap the top end. After construction is complete, these standpipes can, if necessary, be uncapped and connected to one or

more convection stacks or fan-driven vent pipes. When positioning these standpipes, choose locations permitting venting to the roof through already planned flue or plumbing chases, interior walls, or closets. In homes where flue or other chases are restricted in size or not easily accessible, it may be less expensive to go ahead—during the framing and rough-in plumbing/electric phase of construction—and complete the vent pipe hookup, temporarily terminating the vent in the attic along with an electric outlet for future fan installation. Experience has shown that in homes with higher radon levels—above 20 pCi/l—convection (passive) venting may not produce acceptable radon reductions. If lower radon levels are expected and passive venting is attempted, performance is improved by using a 6-inch diameter vent routed straight from the floor through the roof, with minimum bends.

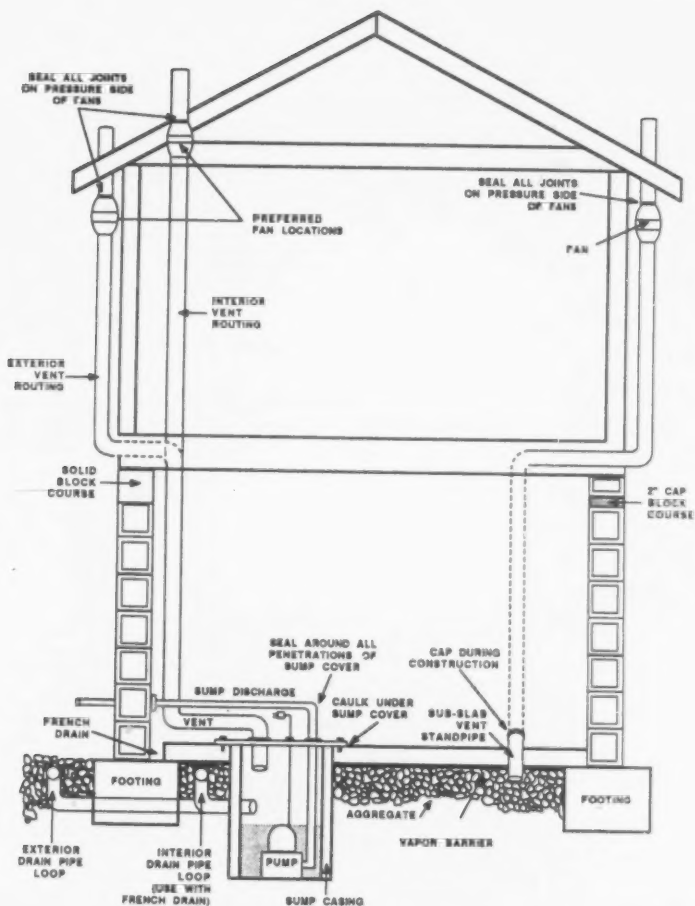
Drilling 4-inch holes through finished slabs for insertion of vent pipes is an alternative to this technique.

- To create the necessary convection flow, radon prevention techniques that involve passive venting normally require stacks that pass through the floors and roof. When active (fan-driven) systems are installed, venting through to the roof is still preferred. Recognizing, however, that active systems can be vented through the band joist or below-grade walls to the outside, it is considered advisable in such active systems to position the exit point of the vent pipe at or above the eave line of the roof and away from any doors or windows. This will preclude any possible recirculation of air containing concentrated radon gas back into the house.
- In homes where an active (fan-driven) sub-slab ventilation system has been installed, it may be necessary to provide make-up air to avoid back drafting.



METHODS TO REDUCE THE VACUUM EFFECT

Figure 3



METHODS TO FACILITATE POST-CONSTRUCTION RADON REMOVAL

Figure 4

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Source of Information

If you would like further information or explanation on any of the points mentioned in this booklet, you should contact your State radiation protection office or home builders association.

If you have difficulty locating these offices, you may call your EPA regional office listed below. They will be happy to provide you with the name, address, and telephone number of these contacts.

STATE-EPA REGION

Alabama-4	Idaho-10	Oklahoma-6	Kentucky-4
Alaska-10	Illinois-5	Oregon-10	New Jersey-2
Arizona-9	Indiana-5	Ohio-6	Texas-6
Arkansas-6	Maryland-3	Pennsylvania-3	Louisiana-6
California-9	Massachusetts-1	Rhode Island-1	New Mexico-6
Colorado-9	Michigan-5	Nebraska-7	Utah-8
Connecticut-1	Minnesota-5	South Carolina-4	North Carolina-4
Delaware-3	Mississippi-4	Iowa-7	Virginia-3
District of Columbia-3	Missouri-7	Nevada-9	West Virginia-3
Florida-4	Montana-8	South Dakota-8	Washington-10
Georgia-4	Maine-1	Kansas-7	Wisconsin-5
Hawaii-9	New York-2	New Hampshire-1	Wyoming-6
	North Dakota-8	Tennessee-4	Vermont-1

EPA REGIONAL OFFICES

EPA Region 1
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Boston, MA 02203
(617) 586-3234

EPA Region 2
28 Federal Plaza
New York, NY 10278
(212) 264-4418

EPA Region 3
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-4094

EPA Region 4
346 Courtland Street, NE
Atlanta, GA 30386
(404) 347-2904

EPA Region 5
230 South Dearborn Street
Chicago, IL 60604
(312) 886-8175

EPA Region 6
1201 Elm Street
Dallas, TX 75270
(214) 656-7296

EPA Region 7
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2853

EPA Region 8
Suite 1200
One Denver Place
900 18th Street
Denver, CO 80202
(303) 293-1848

EPA Region 9
218 Fremont Street
San Francisco, CA 94108
(415) 974-8378

EPA Region 10
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-7880



United States
Environmental Protection
Agency
Washington, DC 20460
Office of Air and Radiation

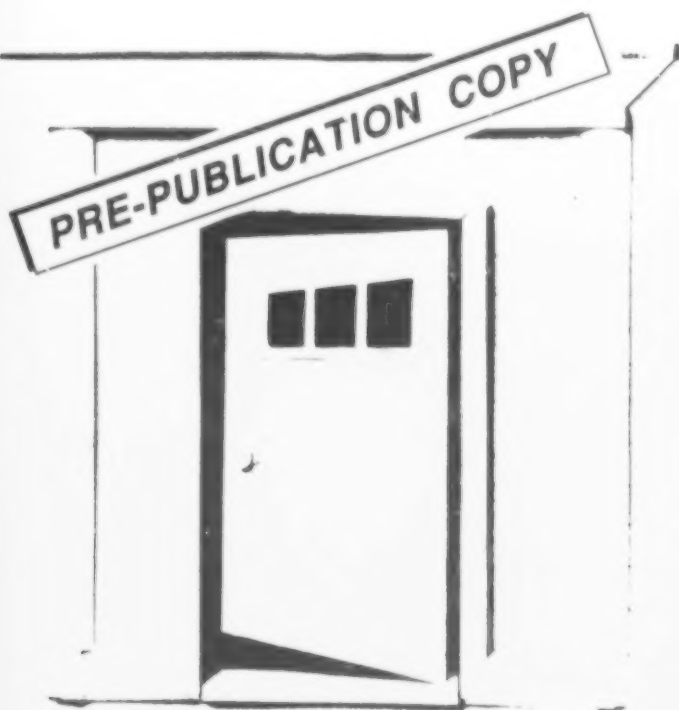
United States
Consumer Product
Safety Commission
Washington, DC 20207

September 1988
EPA/400/1-88/004



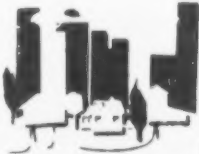
The Inside Story

A Guide to Indoor Air Quality



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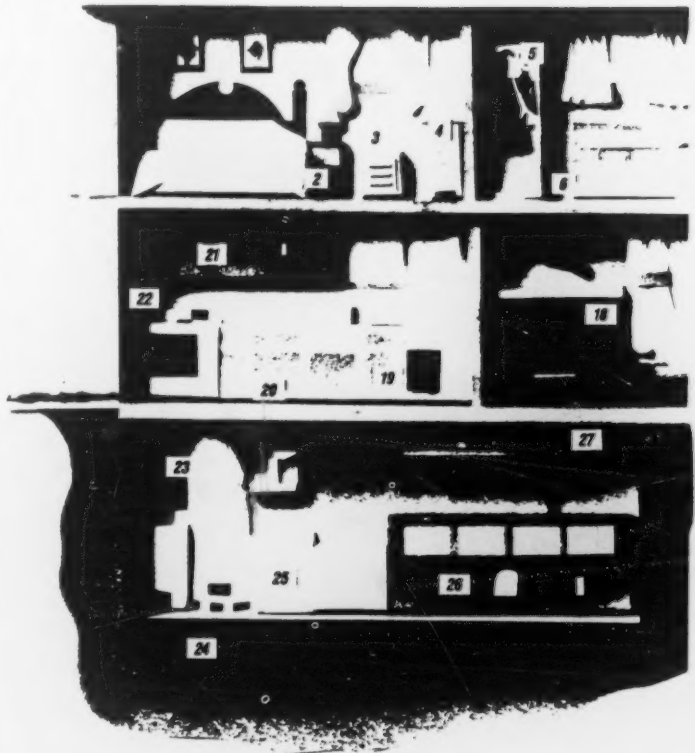
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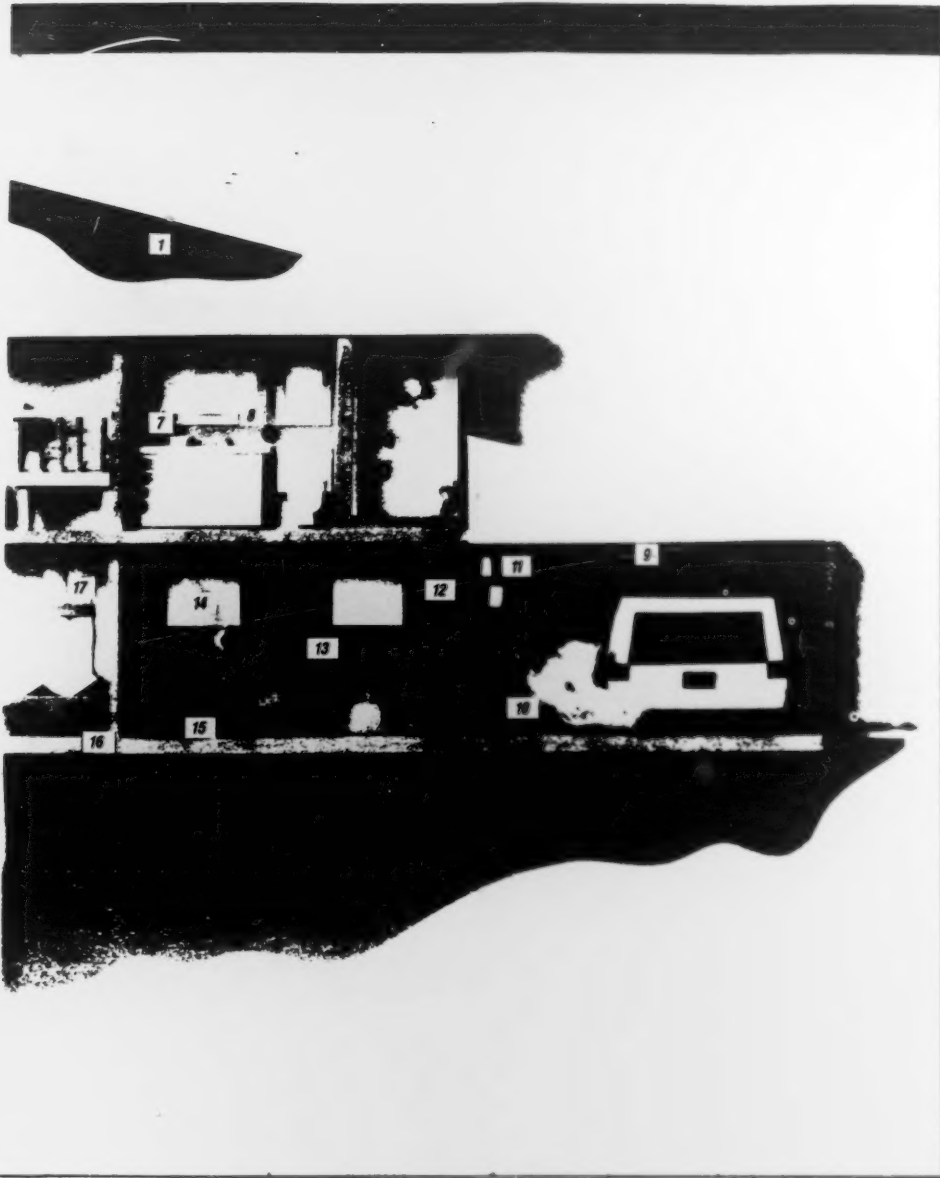
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5. Dry Cleaned Goods
6. House Dust Mites
7. Personal Care Products
8. Air Freshener
9. Stored Fuels
10. Car Exhaust
11. Paint Supplies
12. Paneling
13. Wood Stove
14. Tobacco Smoke
15. Carpets
16. Pressed Wood Subflooring
17. Drapes
18. Fireplace
19. Household Chemicals
20. Asbestos Floor Tiles
21. Pressed Wood Cabinets
22. Unvented Gas Stove
23. Asbestos Pipe Wrap
24. Radon
25. Unvented Clothes Dryer
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INTRODUCTION

**SHOULD YOU BE
CONCERNED ABOUT
INDOOR AIR QUALITY?**

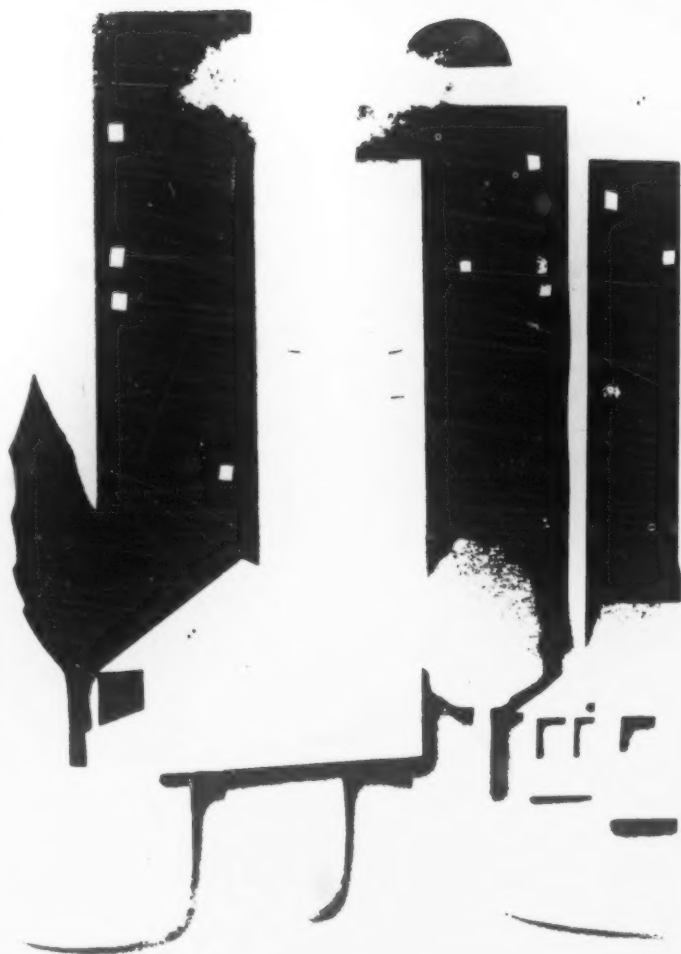
All of us face a variety of risks to our health as we go about our day-to-day lives.

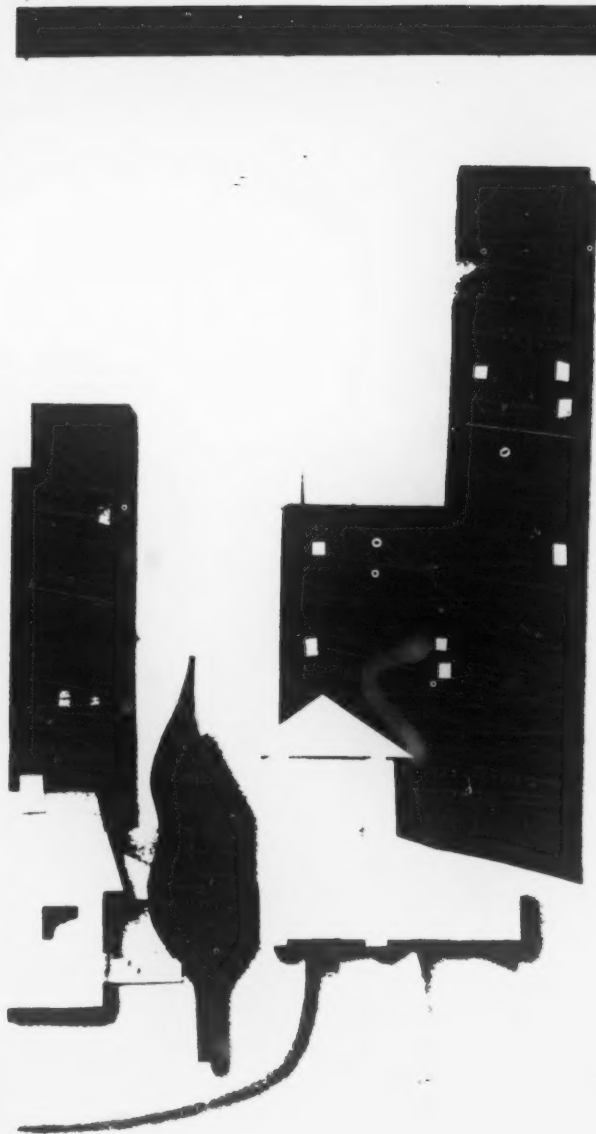
Driving in a car, flying in planes, engaging in recreational activities, and being exposed to environmental pollutants all pose varying degrees of risk.

Some risks are simply unavoidable. Some we choose to accept because to do otherwise would restrict our ability to lead our lives the way we want. And some are risks we might decide to avoid if we had the opportunity to make informed choices.

In the last several years, a growing body of scientific evidence has indicated that the air within homes and other buildings can be more seriously polluted than the outdoor air in even the largest and most industrialized cities. Other research indicates that people spend approximately 90 percent of their time indoors. Thus, for most people, the risks to health may be greater due to exposure to air pollution indoors than outdoors.

In addition, people who may be exposed to indoor air pollutants for the longest periods of time are often those most susceptible to the adverse effects of indoor air pollution. Such groups include the young, the elderly, and the chronically ill, especially those suffering from respiratory or cardiovascular disease.





WHY A BOOKLET ON INDOOR AIR?

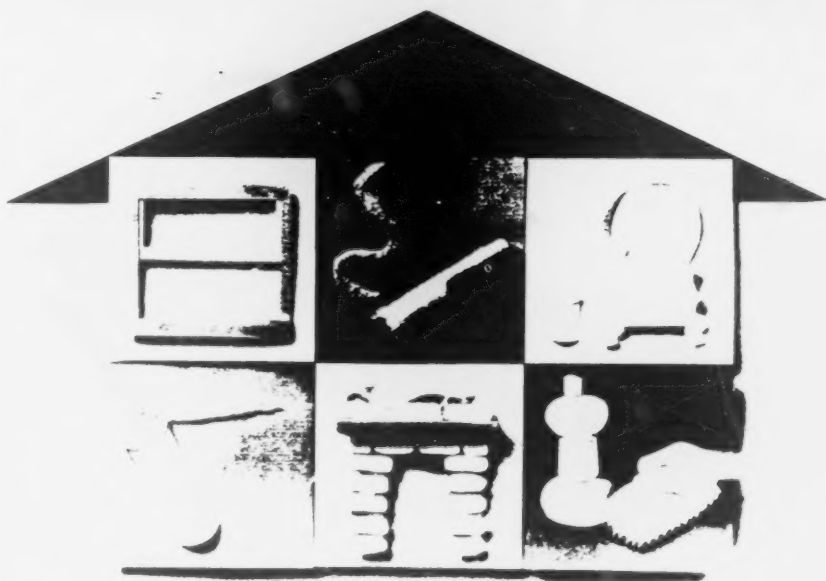
The levels of pollutants from individual sources may not pose a significant risk to health by themselves. But most homes have more than one source that contributes to indoor air pollution. There can be a serious risk from the cumulative effects of these sources. Fortunately, however, there are steps that most households can take both to reduce the risk from existing sources and to prevent new problems from occurring.

This booklet was prepared by the U.S. Environmental Protection Agency (EPA) and the U.S. Consumer Product Safety Commission (CPSC) to help you decide whether to take actions in your home that can reduce the level of indoor air pollution.

Because so many Americans spend a substantial amount of time in offices with mechanical heating, cooling, and ventilation systems, there is also a short section on the causes of poor air quality in offices and what you can do if you suspect that your office may have a problem.

A glossary and a list of public and private organizations where you can get additional information are listed at the back of this booklet.

INDOOR AIR-QUALITY IN YOUR HOME



WHAT CAUSES INDOOR AIR QUALITY PROBLEMS?

Indoor pollution sources release gases or particles into the air and are the primary cause of indoor air quality problems in homes. Inadequate ventilation can increase indoor pollutant levels by not bringing in sufficient outside air to dilute emissions from indoor sources and by not carrying indoor air pollutants out of the home. High temperature and humidity levels can also increase concentrations of some pollutants.

■ **Pollutant sources:** There are many potential sources of indoor air pollution in any home. These sources fall into several general categories:

oil, gas, kerosene, coal, or wood combustion sources; building materials and furnishings as diverse as deteriorated asbestos-containing insulation, wet or damp carpeting, and cabinetry or furniture made of certain pressed wood products; products for household cleaning and maintenance, personal care, or hobbies; central heating and cooling systems and humidification devices; and outside sources such as radon, pesticides, and outdoor air pollution.

The relative importance of any single source depends on how much of a given pollutant it emits and how hazardous those emissions are. In some cases, factors such as how old the source is and whether it is properly main-

tained are significant. For example, an improperly adjusted gas stove can emit significantly more carbon monoxide than one that is properly adjusted.

Some sources, such as building materials, furnishings, and household products such as air fresheners, release pollutants more or less continuously. Other sources, related to activities carried out in the home, release pollutants intermittently. Such activities include smoking, the use of unvented or malfunctioning stoves, furnaces, or space heaters, the use of solvents in cleaning and hobby activities, the use of paint strippers in redecorating activities, and the use of cleaning products and pesticides in housekeeping. High pollutant

concentrations can remain in the air for long periods after some of these activities.

■ **Amount of ventilation:** If too little outdoor air enters a home, pollutants can accumulate to levels that can pose health and discomfort problems. Unless they are built with special mechanical means of ventilation, homes that are designed and constructed to minimize the amount of outside air that can "leak" into and out of the home may have higher pollutant levels than other homes. However, because some weather conditions can drastically reduce the amount of outside air that enters a home, pollutants can build up even in homes that are normally considered "leaky."

HOW DOES OUTSIDE AIR ENTER A HOUSE?

Outside air enters and leaves a house in three ways. In a process known as *infiltration*, air flows through construction joints and cracks around windows and doors, in the foundation, or from crawl spaces underneath homes. In another process known as *natural ventilation*, air enters through opened windows and doors. Finally, there are a number of *mechanical ventilation* devices, from outdoor-vented fans that remove air from a single room to air handling systems that have fans that mix outdoor and indoor air or that remove polluted air from the whole house. The rate at which outside air replaces indoor air is described as the *air exchange rate*. When there is little infiltration, natural ventilation, or mechanical ventilation, the air exchange rate is low and pollutant levels can increase.

The average air exchange rate of homes in the United States today is 0.7 to 1.0 air changes per hour; in relatively tight homes, it can be as low as 0.2 to 0.3 air changes per hour; and in "leaky" homes, it may be as much as 2.0 air changes per hour. It is important to understand that an air exchange rate of 1.0 air change per hour does not mean that all pollutants will be removed in one hour. Ventilation is a process of dilution and removal that gradually gets rid of pollutants. In addition, pollutant removal is further slowed down by the fact that some pollutants are "trapped" by carpets, drapes, and other surfaces, only to be re-released into the air later.



WHAT IF YOU LIVE IN AN APARTMENT?

Apartments can have many of the same indoor air problems as single-family homes because many of the pollution sources, such as the interior building materials, furnishings, and household products, are similar. Indoor air problems similar to those caused in offices by such sources as contaminated ventilation

systems, improperly placed outdoor air intakes, or maintenance activities also can occur in apartments.

Solutions to air quality problems in apartments, as in homes and offices, involve one or more of the following actions: eliminating or controlling the sources of pollution, increasing ventilation, or installing air cleaning devices. Often a

resident can take the appropriate action to improve the indoor air quality by removing a source, altering an activity, unblocking an air supply vent, or opening a window to temporarily increase the ventilation; in other cases, however, only the building owner or manager is in a position to remedy the problem.



HOW DOES INDOOR AIR POLLUTION AFFECT YOUR HEALTH?

Health effects from indoor air pollutants fall into two categories: those that are experienced immediately after exposure and those that do not show up until years later.

Immediate effects, which may show up after a single exposure or repeated exposures, include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. These immediate effects are usually short-term and treatable by some means. Sometimes the treatment is simply eliminating the person's exposure to the source of the pollution, if it can be identified. Symptoms of some diseases, including asthma, hypersensitivity pneumonitis, and humidifier fever, can also show up soon after exposure to some indoor air pollutants.

The likelihood of an individual developing immediate reactions to indoor air pollutants depends on several factors. Age and pre-existing medical conditions are two important influences. In other cases, whether a person reacts to a pollutant can be determined by individual sensitivity, which varies tremendously from person to person. Some

people can become sensitized to biological pollutants after repeated exposures, and it appears that some people can become sensitized to chemical pollutants as well.

Certain immediate effects are similar to those from colds or other viral diseases, so it is often difficult to determine if the symptoms are a result of exposure to indoor air pollution. For this reason, it is important to pay attention to the time and place the symptoms occur. If the symptoms fade or go away when a person is away from the home and return when the person returns home, an effort should be made to identify indoor air sources that may be possible causes. Some effects may be made worse by an inadequate supply of outside air or from the heating, cooling, or humidity conditions prevalent in the home.

Other health effects may show up either years after exposure has occurred or only after long or repeated periods of exposure. These effects, which include emphysema and other respiratory diseases, heart disease, and cancer, can be severely debilitating or fatal. More information on potential health effects from particular indoor air pollutants is provided in the section, "What Can You Do To Improve the Air Quality in

Your Home?"

While pollutants commonly found in indoor air can be responsible for many harmful effects, there is considerable uncertainty about what concentrations or periods of exposure are necessary to produce specific health effects. People also react very differently to exposure to indoor air pollutants. Further research is needed to better understand which health effects can occur after exposure to the average pollutant concentrations found in homes and which can occur from the higher concentrations that occur for short periods of time.

The health effects associated with some indoor air

pollutants are summarized in the chart in the middle of this booklet entitled

"Reference Guide to Major Indoor Air Pollutants in the Home." (This chart can be removed and used as a hand-out.)

HOW DO YOU KNOW IF YOU HAVE AN AIR QUALITY PROBLEM IN YOUR HOME?

Some health effects can be useful indicators of an indoor air quality problem, especially if they appear after a person moves to a new residence, remodels or refurnishes a home, or treats a home with pesticides. If you think that you have



symptoms that may be related to your home environment, you should discuss with your doctor or your local health department whether such symptoms could be caused by indoor air pollution. You may also want to consult a board-certified allergist or an occupational medicine specialist for answers to your questions.

It is prudent to try to improve the indoor air quality in your home even if symptoms are not noticeable. The earliest symptoms of long-term health problems, such as some respiratory illnesses and cancer, do not appear until years after the initial exposure.

Another way to judge whether your home has or could develop indoor air problems is to identify potential sources of indoor air pollution. Although the presence of such sources (see illustration at the beginning of this booklet) does not necessarily mean that you have an indoor air quality problem, being aware of the type and number of potential sources is an important step toward assessing the quality of air in your home.

A third way to decide whether your home may have poor indoor air quality is to look at your lifestyle and activities. As discussed earlier, human activities can be significant sources of indoor air pollution.

Finally, look for signs of problems with the air flow through your home. Things that can indicate your home may have an indoor air quality problem include smelly or stuffy air, dirty central heating and air cooling equipment, damaged flues and chimneys, moisture condensation on windows or walls, signs of water leakage, and areas where books, shoes, or other items become moldy.

SHOULD YOU MEASURE POLLUTANT LEVELS IN YOUR HOME?

The federal government recommends that you measure the level of radon in your home. Without measurements there is no way to tell whether radon is present. Inexpensive devices are available for measuring radon. EPA provides guidance as to risks associated with different levels of exposure and when the public should consider corrective action. There are specific mitigation techniques that have proven effective in reducing levels of radon in the home. (See "Radon" section on p. 11 of this booklet for additional information about testing and controlling radon in homes.)

For pollutants other than radon, measurements are most appropriate when there are either health symptoms or signs of poor air flow and specific sources or pollutants have been identified as possible causes of indoor air quality problems. Testing for many pollutants can be expensive. Before monitoring your home for pollutants besides radon, consult with your state or local health department or with professionals who have experience in solving indoor air quality problems in non-industrial buildings.

SHOULD YOU WEATHERIZE YOUR HOME?

The federal government recommends that homes be weatherized in order to reduce the amount of energy needed for heating and cooling. While weatherization is underway,



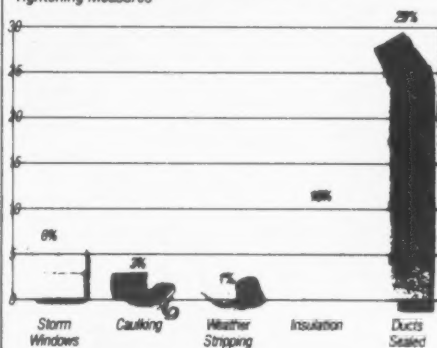
however, steps should be taken to minimize pollution from sources inside the home. (See "What Can You Do To Improve the Air Quality in Your Home?" for recommended actions.) In addition, residents should be alert to the emergence of signs of inadequate air flow, such as stuffy air, moisture condensation on cold surfaces, or mold and mildew growth. Additional weatherization measures should not be undertaken until these problems have been corrected.

Weatherization generally does not cause indoor air problems by adding new pollutants to the air. (There

are a few exceptions, such as caulking, that can sometimes emit pollutants.) However, measures such as installing storm windows, weather stripping, caulking, and blown-in wall insulation can reduce the amount of outdoor air infiltrating into a home. Consequently, after weatherization, concentrations of indoor air pollutants from sources inside the home can increase.

Some measures that reduce energy costs can actually reduce indoor pollutant levels. For example, sealing foundation cracks can save on energy bills while helping prevent the entry of radon gas into homes.

Percent Reduction in Air-Exchange Rate By House-Tightening Measures



Depending on which of these measures are used, a home's natural infiltration rate can be reduced by up to about 30 percent.

Source: Bonneville Power Administration

WHAT CAN YOU DO TO IMPROVE THE AIR QUALITY IN YOUR HOME?



THREE BASIC STRATEGIES

Source Control: Usually the most effective way to improve indoor air quality is to eliminate individual sources of pollution or to reduce their emissions. Some sources, like those that contain asbestos, can be sealed or enclosed; others, like gas stoves, can be adjusted to decrease the amount of emissions. In some cases, source control is also a more cost-efficient approach to protecting indoor air quality than increasing ventilation because increasing ventilation can increase energy costs. Specific steps that you can take to control specific sources of indoor air pollution in your home are listed later in this section.

Ventilation Improvements: Another approach to lowering the concentrations of indoor air pollutants in your home is to increase the amount of outside air coming indoors. Opening windows and doors, when the weather permits, increases the natural ventilation rate. Turning on local bathroom or kitchen exhaust fans, if they are vented to the outdoors, can lower pollution levels by removing contaminants from the room where the fan is located. Where radon may be a problem, a window should be opened while bathroom or kitchen exhaust fans are in use. This keeps the amount of radon entering the house from increasing.

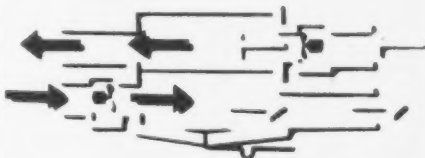
It is particularly important to take as many of these steps as possible while you

are involved in short-term activities that can generate high levels of pollutants—for example, painting, paint stripping, heating with kerosene heaters, cooking with gas stoves that are not vented to the outdoors, or engaging in maintenance and hobby activities such as welding, soldering, or sanding. You might also choose to do some of these activities outside, if you can and if weather permits.

Another way to increase the mechanical ventilation rate is to install heat recovery ventilators (also known as air-to-air heat exchangers) in homes. These devices, which can be installed in windows or as part of a central air system, increase ventilation by drawing outside air into the home and conserve energy by recovering the heat from air that is exhausted to the outdoors. Heat recovery ventilators are most easily installed in central air systems in new homes or during extensive remodeling; window units can be installed in existing homes.

Before you buy a mechanical ventilation device for your home, you should read books and articles on these devices and consult a mechanical engineer. Write Renewable Energy Information, P.O. Box 8900, Silver Spring, MD 20907 for the U.S. Department of Energy fact sheet, *Air-to-Air Heat Exchangers*. You can look in the yellow pages of a telephone directory under "Engineers" or write the American Society Of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) for the name of the president of the local ASHRAE organization in your community. (For ASHRAE's address, see p. 31)

Air Cleaners: There are many types and sizes of air cleaners on the market, ranging from relatively inexpensive tabletop models to sophisticated and expensive whole-house systems. Some air cleaners are highly effective at particle removal, while others, including most



Heat Recovery Ventilator

A heat recovery ventilator draws stale, warm air from the house and transfers the heat in that air to the cold air being pulled into the house. This additional outdoor air can help dilute air pollutant concentrations indoors. If appropriately designed and installed, these devices can reduce the energy costs associated with the increased ventilation.

Source: U.S. Department of Energy

A LOOK AT SOURCE SPECIFIC CONTROLS

tabletop models, are much less efficient. Air cleaners are generally not designed to remove gaseous pollutants.

How well an air cleaner works depends on how well it collects pollutants from indoor air (expressed as a percentage efficiency rate) and how much air it draws through the cleaning or filtering element (expressed in cubic feet per minute). A very efficient collector with a low air circulation rate will not be effective, nor will a cleaner with a high air circulation rate but a less efficient collector. The long-term performance of any air cleaner depends on maintaining it according to the manufacturer's directions.

Another important factor in determining the effectiveness of an air cleaner is the strength of the pollutant source. Tabletop air cleaners, in particular, may not remove satisfactory amounts of pollutants from strong nearby sources. People with a sensitivity to particular sources may find that air cleaners are helpful only in conjunction with concerted efforts to remove the source.

Both EPA and CPSC plan to undertake more studies to evaluate the effectiveness of air cleaners that are on the market today and to identify improvements in the way air cleaners can be designed, operated, and maintained.

At present, EPA does not recommend using air cleaners to reduce levels of radon and its decay products. The effectiveness of these devices is uncertain because they only partially remove the radon decay products and do not diminish the amount of radon entering the home. EPA plans to do additional research on whether air cleaners are, or could become, a reliable means of reducing the health risk from radon.



For most indoor air quality problems in the home, source control is the most effective solution. This section takes a source-by-source look at the most common indoor air pollutants, their potential health effects, and ways to reduce levels in the home. (For a summary of the points made in this section, see the chart in the middle of this booklet entitled "Reference Guide to Major Indoor Air Pollutants in the Home.")

RADON

Radon is a colorless, odorless gas that occurs naturally and is found everywhere at very low levels. It is when radon becomes trapped in buildings and concentrations build up in indoor air that exposure to radon becomes of concern.

The most common source of indoor radon is uranium in the soil or rock on which homes are built. As uranium naturally breaks down, it releases radon gas, and radon

gas breaks down into radon decay products (also called radon daughters or progeny). Radon gas enters homes through dirt floors, cracks in concrete walls and floors, floor drains, and sumps.

A second entry route for radon in some areas of the country is through well water. In some unusual situations, houses are made of radon-containing construction materials; in such cases, those materials can release radon into the indoor air.

Studies by EPA indicate that as many as 10 percent of all American homes, or about 8 million homes, may have elevated levels of radon, and the percentage may be higher in geographic areas with certain soils and bedrock formations. Radon can be detected only by the use of measurement instruments called radon detectors.

Health Effects of Radon

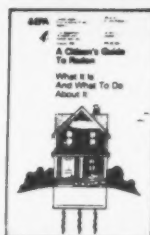
The only known health effect associated with exposure to elevated levels of radon is lung cancer. EPA estimates that about 5,000 to

20,000 lung cancer deaths a year in the United States may be attributed to radon. (The American Cancer Society estimates there will be a total of about 139,000 lung cancer deaths in 1988 from all causes.)

Reducing Exposure to Radon in Homes

• **Measure levels of radon in your home.** Two types of radon detectors are most commonly used in homes: charcoal canisters that are exposed for 2 to 7 days; and alpha track detectors that are exposed for one month or longer. (Some states recommend that residents use only the alpha track monitors.)

Your state radiation protection office can provide you with information on the availability of detection devices or services. Ask for materials specifically developed for your state and for EPA's *A Citizen's Guide to Radon*. States may also provide you with EPA's *Radon Measurement Proficiency Report* for your state. This publication lists firms and laboratories that have demonstrated



their ability to accurately measure radon in homes.

You can also get the booklets listed in this section from the EPA Public Information Center or the EPA regional office nearest you. (See p. 30 for a list of EPA headquarters and regional office addresses.)

■ **Refer to the EPA guidelines in deciding whether and how quickly to take action based on your test results.**

The guidelines are given in the booklet, *A Citizen's Guide to Radon*. The higher the radon level in your home, the faster you should take action to reduce your exposure. EPA believes that radon levels in homes can be reduced to about 4 picocuries per liter of air and sometimes less.

■ **Learn about control measures.** An effective radon mitigation plan may include one or more of the following actions: sealing cracks and other openings in basement floors, ventilating crawl spaces, installing sub-slab or basement ventilation, or installing air-to-air heat exchangers. The EPA booklet, *Radon Reduction Methods: A Homeowner's Guide*, describes some possible reduction measures.

■ **Take precautions not to draw larger amounts of radon into the house.** Increasing ventilation can be



an effective means of reducing exposure to many indoor air pollutants; in homes with elevated concentrations of radon, however, increasing ventilation may increase infiltration through the foundation and result in drawing even larger amounts of radon into the home. You can get the benefits of increased ventilation without increasing radon exposure by opening windows evenly on all sides of the home. Opening windows is particularly important when you are using outdoor-vented exhaust fans.

■ **Select a qualified contractor to draw up and implement a radon mitigation plan.** EPA suggests that all but the most experienced "do-it-yourselfers" get professional help in selecting and installing radon reduction measures. The EPA booklet, *Radon Reduction Methods: A Homeowner's Guide*, offers advice about how to select a contractor and how to evalu-

ate proposals for radon mitigation. EPA does not certify contractor competency for planning or executing radon mitigation measures.

■ **Stop smoking and discourage smoking in your home.** Scientific evidence indicates that smoking may increase the risk of cancer associated with exposure to radon.

■ **Treat radon-contaminated well water by aerating or filtering through granulated-activated charcoal.**

Contact your state's radiation protection office or drinking water office for more information concerning radon in drinking water in your community.

ENVIRONMENTAL TOBACCO SMOKE

Environmental tobacco smoke is composed of sidestream smoke (the smoke that comes from the burning end of a cigarette) and smoke that is exhaled by the smoker. It is a complex mixture of over 4,700 compounds, including both gases and particles. Non-smokers' exposure to environmental tobacco smoke is called "passive smoking," "second-hand smoking," or "involuntary smoking."

Health Effects of Environmental Tobacco Smoke

According to reports issued in 1986 by the Surgeon General and the National Academy of Sciences, environmental tobacco smoke is a cause of

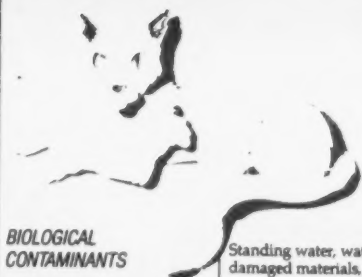
disease, including lung cancer, in both smokers and healthy non-smokers. Studies indicate that exposure to tobacco smoke may increase the risk of lung cancer by an average of 30 percent in the non-smoking spouses of smokers. Very young children exposed to smoking at home are more likely to be hospitalized for bronchitis and pneumonia. Recent studies suggest that environmental tobacco smoke may also contribute to heart disease.

Reducing Exposure to Environmental Tobacco Smoke in Homes

■ **Give up smoking and discourage smoking in your home or ask smokers to smoke outdoors.** The 1986 Surgeon General's report concluded that physical separation of smokers and nonsmokers in a common air space, such as different rooms within the same house, may reduce—but will not eliminate—nonsmokers' exposure to environmental tobacco smoke.

Ventilation, a common method of reducing exposure to indoor air pollutants, also will reduce but not eliminate exposure to environmental tobacco smoke. Because smoking produces such large amounts of pollutants, natural or mechanical ventilation techniques do not remove them from the air in your home as quickly as they build up. In addition, the large increases in ventilation it takes to significantly reduce exposure to environmental tobacco smoke can also increase energy costs substantially.

Consequently, the most effective way to reduce exposure to environmental tobacco smoke in the home is to eliminate smoking there.



BIOLOGICAL CONTAMINANTS

Biological contaminants ("biologicals") include bacteria, mold and mildew, viruses, animal dander and cat saliva, mites, cockroaches, and pollen. There are many sources for these pollutants. For example, pollens originate from plants; viruses are transmitted by people and animals; bacteria are carried by people, animals, and soil and plant debris; and household pets are sources of saliva and animal dander. The protein in urine from rats and mice is a potent allergen; when it dries, it can become airborne. Contaminated central air handling systems can become breeding grounds for mold, mildew, and other biological contaminants and can then distribute these contaminants through the home.

By controlling the relative humidity level in a home, the growth of biologicals can be minimized. A relative humidity of 30-50 percent is recommended for homes.

Standing water, water-damaged materials, or wet surfaces can serve as a breeding ground for molds, mildews, bacteria, and insects. House dust mites, one of the most powerful biologicals in triggering allergic reactions, can grow in any damp, warm environment.

Health Effects From Biological Contaminants

Some biological contaminants trigger allergic reactions, including hypersensitivity pneumonitis, allergic rhinitis, and some types of asthma. Some transmit infectious illnesses, such as influenza, measles, and chicken pox. And some biologicals, such as certain molds and mildews, release disease-causing toxins. Symptoms of health problems caused by biological pollutants include sneezing, watery eyes, coughing, shortness of breath, dizziness, lethargy, fever, and digestive problems.

Many allergic reactions caused by biological aller-

gens occur immediately after exposure; other allergic reactions are the result of previous exposures that a person may not have been aware of. As a result, people who have noticed only mild allergic reactions, or no reactions at all, may suddenly find themselves very sensitive to particular allergens. Some diseases, like humidifier fever, have generally been associated with exposure to toxins from microorganisms that can grow in large building ventilation systems. However, these diseases can also be traced to microorganisms that grow in home heating and cooling systems and humidification devices. Children, elderly people, and people with breathing problems, allergies, and lung diseases are particularly susceptible to disease-causing biological agents in the indoor air.

Reducing Exposure to Biological Contaminants in Homes

■ **Install and use exhaust fans that are vented to the outdoors in kitchens and bathrooms and vent clothes dryers outdoors.** These actions can eliminate much of the moisture that builds up from everyday activities. There are exhaust fans on the market that produce little noise, an important consideration for some people. (Another benefit to using kitchen and bathroom exhaust fans is that they can reduce levels of organic pollutants that vaporize from hot water used in showers and dishwashers.)

■ **Ventilate the attic and crawl spaces to prevent moisture build-up.** Keeping humidity levels in these areas between 30-50 percent can prevent water condensation on building materials.





• If using cool mist or ultrasonic humidifiers, clean water trays and fill with fresh, distilled water daily. Because these humidifiers can become breeding grounds for biological contaminants, they have the potential for causing diseases such as hypersensitivity pneumonitis. Evaporation trays in air conditioners, dehumidifiers, and refrigerators should also be cleaned frequently.

• Thoroughly dry and clean water-damaged carpets and building materials (within 24 hours if possible). Water-damaged carpets and building materials can harbor mold and bacteria. If health problems persist after you have tried to dry these materials, consider replacing them. It can be very difficult to completely rid such materials of biological contaminants.

• Keep the house clean. House dust mites, pollens, animal dander, and other allergy-causing agents can be reduced, although not eliminated, through regular cleaning. People who are allergic to these pollutants should not vacuum (and may even need to leave the house while vacuuming is occurring), because vacuuming can actually increase levels of airborne mite

allergens and other biological contaminants. Using central vacuum systems that are vented to the outdoors may reduce allergic reactions to biologicals.

• Take steps to minimize biological pollutants in basements. Clean and disinfect the basement floor drain regularly. Do not finish a subsurface basement unless all water leaks are patched and outdoor ventilation and adequate heat to prevent condensation are provided. Operate a dehumidifier in the basement if needed to keep relative humidity levels between 30-50 percent.



Dust mites, microscopic animals found in household dust, produce a common allergen. Exposure to house dust mites, animal-related allergens (animal dander and cat saliva), and mold have been estimated to cause 200,000 or more emergency room visits a year by asthma patients. Humid or damp conditions usually lead to greater numbers of dust mites.

STOVES, HEATERS, FIREPLACES, AND CHIMNEYS

In addition to environmental tobacco smoke, other sources of combustion products are unvented kerosene and gas space heaters, woodstoves, fireplaces, and gas stoves. The major pollutants released from these sources are carbon monoxide, nitrogen dioxide, and particulates. In addition, woodstoves, fireplaces, and unvented kerosene space heaters emit polycyclic aromatic hydrocarbons. Unvented kerosene heaters may also generate acid aerosols.

Other sources of combustion gases and particulates are chimneys and flues that are improperly installed or maintained and cracked furnace heat exchangers. Pollutants from fireplaces and woodstoves with no outside air supply vent can be "down-drafted" from the chimney back into the living space, particularly in "weather-tight" homes.

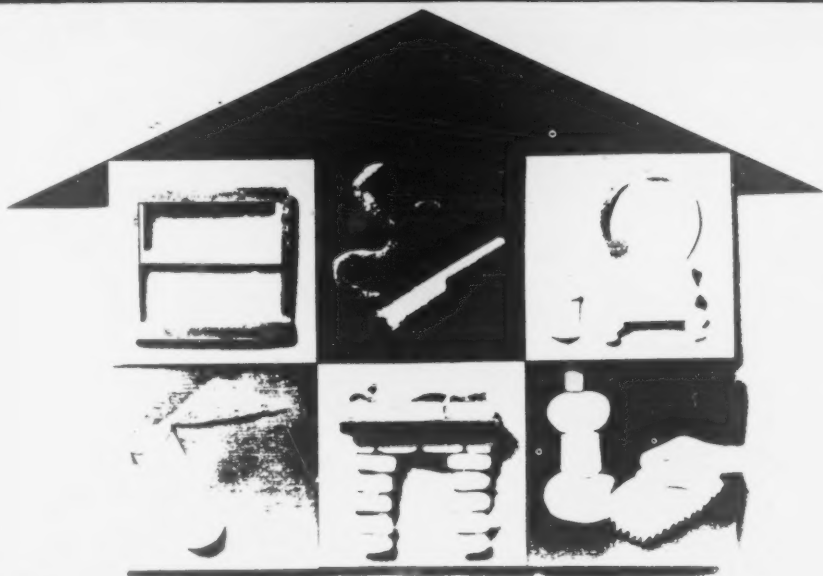
Health Effects of Combustion Products

Carbon monoxide is a colorless, odorless gas that interferes with the delivery of oxygen throughout the body. At low concentrations, it can cause fatigue in healthy people and episodes of increased chest pain in people with chronic heart disease. At higher concentrations, carbon monoxide can cause headaches, dizziness, weakness, nausea, confusion, and disorientation. The symptoms of carbon monoxide poisoning are sometimes confused with the flu or food poisoning. At very high concentrations carbon monoxide can cause unconsciousness and death. Fetuses, infants, pregnant women, elderly people, and people with anemia or with a history of heart or respiratory disease can be especially sensitive to carbon monoxide exposures.

Nitrogen dioxide can irritate the mucous membranes in the eye, nose, and throat and cause shortness of breath after exposure to high concentrations. There is evidence that high concentrations or continued exposure to low levels of nitrogen dioxide can increase the risk of respiratory infection; there is also evidence from animal studies that repeated exposures to elevated nitrogen dioxide levels may lead, or contribute, to the development of lung disease such as emphysema. People at particular risk from exposure to nitrogen dioxide include children and individuals with asthma and other respiratory diseases.

Respirable particles, released when fuels are incompletely burned, can lodge in the lungs and irritate or damage lung tissue. A number of pollutants, including radon (continued on page 19)

REFERENCE GUIDE TO MAJOR INDOOR AIR POLLUTANTS IN THE HOME



The pollutants listed in this guide have been shown to cause the health effects mentioned. However, it is not necessarily true that the effects noted occur at the pollutant concentration levels typically found in the home. In many cases, our understanding of the pollutants and their health effects is too limited to determine the levels at which the listed effects could occur.

RADON

Sources: Earth and rock beneath home; well water; building materials.

Health Effects: No immediate symptoms. Estimated to cause about 10% of lung cancer deaths. Smokers are at higher risk of developing radon-induced lung cancer.

Levels in Homes: Estimated national average is 1½ picocuries per liter. Levels in homes have been found as high as 200 picocuries per liter. The higher the average concentration, the faster the corrective action should be taken. EPA believes that levels in most homes can be

reduced to 4 picocuries per liter of air and sometimes less.

Steps to Reduce Exposure:

- Test your home for radon.
- Get professional advice before planning and carrying out radon reduction measures.
- Seal cracks and other openings in basement floor.
- Ventilate crawl space.
- Install sub-slab ventilation or a heat recovery ventilator (air-to-air heat exchanger.)
- Treat radon-contaminated well water by aerating or filtering through granulated-activated charcoal.

ENVIRONMENTAL TOBACCO SMOKE

Sources: Cigarette, pipe, and cigar smoking.

Health Effects: Eye, nose, and throat irritation; headaches; bronchitis; pneumonia. Increased risk of respiratory and ear infections in children. Can cause lung cancer and may contribute to heart disease.

Levels in Homes: Particle levels in homes without smokers or other strong particle sources are the same as, or lower than, those outdoors. Homes with one or more smokers may have

particle levels several times higher than outdoor levels.

Steps to Reduce Exposure:

- Stop smoking and discourage others from smoking.
- If you do smoke, smoke outdoors.

BIOLOGICALS

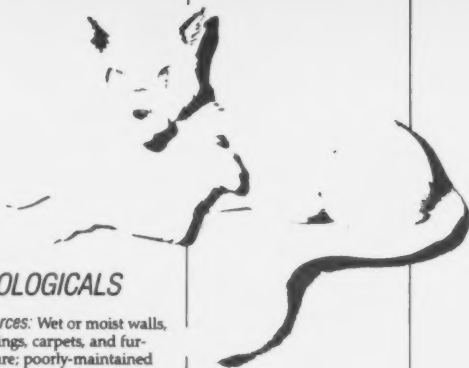
Sources: Wet or moist walls, ceilings, carpets, and furniture; poorly-maintained humidifiers, dehumidifiers, and air conditioners; bedding; household pets.

Health Effects: Eye, nose, and throat irritation; shortness of breath; dizziness; lethargy; fever; digestive problems. Asthma; humidifier fever; influenza and other infectious diseases.

Levels in Homes: Indoor levels of pollen and fungi are lower than outdoor levels (except where indoor sources of fungi are present). Indoor levels of mites are higher than outdoor levels.

Steps to Reduce Exposure:

- Install and use fans vented to outdoors in kitchens and bathrooms.
- Vent clothes dryers to outdoors.
- Clean cool mist and ultrasonic humidifiers daily and use only distilled water in them.
- Empty water trays in air conditioners, dehumidifiers, and refrigerators frequently.
- Clean and dry, or remove, water-damaged carpets.
- Use basements as living areas only if they are leak-proof and have adequate ventilation. Use dehumidifiers, if necessary to maintain humidity at 30-50 percent.



CARBON MONOXIDE

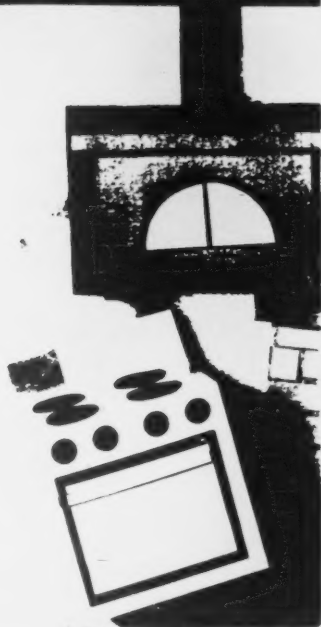
Sources: Unvented kerosene and gas heaters; leaking chimneys and furnaces; down-drafting from wood stoves and fireplaces; gas stoves. Automobile exhaust from attached garages. Environmental tobacco smoke.

Health Effects: At low concentrations, fatigue in healthy people and chest pain in people with heart disease. At higher concentrations, impaired vision and coordination; headaches; dizziness; confusion; nausea. Can cause flu-like symptoms that clear up after leaving home. Fatal at very high concentrations.

Levels in Homes: Average levels in homes without gas stoves vary from 0.5 to 5 parts per million (ppm). Levels near properly adjusted gas stoves are often 5 to 15 ppm and near poorly adjusted stoves may be 30 ppm or higher.

Steps to Reduce Exposure:

- Keep gas appliances properly adjusted.
- Consider purchasing vented gas space heaters and furnaces.
- Use proper fuel in kerosene space heaters.
- Install and use exhaust fan vented to outdoors over gas stoves.
- Open flues when gas fireplaces are in use.
- Choose properly sized wood stoves that are certified to meet EPA emission standards. Make certain that doors on all wood stoves fit tightly.
- Have a trained professional inspect, clean, and tune-up central heating system (furnaces, flues, and chimneys) annually. Repair any leaks properly.
- Do not idle car inside garage.



NITROGEN DIOXIDE

Sources: Kerosene heaters, unvented gas stoves and heaters. Environmental tobacco smoke.

Health Effects: Eye, nose, and throat irritation; may cause impaired lung function and increased respiratory infections in young children.

Levels in Homes: Average level in homes without combustion appliances is about half that of outdoors. In homes with gas stoves, kerosene heaters, or unvented gas space heaters indoor levels often exceed outdoor levels.

Steps to Reduce Exposure:

- See steps under carbon monoxide.

OR AIR POLLUTANTS IN THE HOME



RESPIRABLE PARTICLES

Sources: Fireplaces, wood stoves, and kerosene heaters. Environmental tobacco smoke.

Health Effects: Eye, nose, and throat irritation; respiratory infections and bronchitis; lung cancer. (Effects attributable to environmental tobacco smoke are listed elsewhere.)

Levels in Homes: Particle levels in homes without smoking or other strong particle sources are the same as, or lower than, outdoor levels.

Steps to Reduce Exposure:

- Vent all furnaces to outdoors; keep doors to rest of house open when using unvented space heaters.
- Choose properly sized wood stoves, certified to meet EPA emission standards; make certain that doors on all wood stoves fit tightly.
- Have a trained professional inspect, clean, and tune-up central heating system (furnace, flues, and chimneys) annually. Repair any leaks promptly.
- Change filters on central heating and cooling systems and air cleaners according to manufacturer's directions.

EXTERIOR
GRADE

ORGANIC GASES

Sources: Household products including: paints, paint strippers, and other solvents; wood preservatives; aerosol sprays; cleansers and disinfectants; moth repellents and air fresheners; stored fuels and automotive products; hobby supplies; dry cleaned clothing.

Health Effects: Eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system.

Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans.

Levels in Homes: Levels of several organics average 2 to 5 times higher indoors than outdoors. During and for several hours immediately after certain activities, such as paint stripping, levels may be 1000 times background outdoor levels.

Steps to Reduce Exposure:

- Use household products according to manufacturer's directions.
- Use outdoors or in well-ventilated places.
- Throw away unused or little-used containers safely; buy in quantities that you will use soon.

FORMALDEHYDE

Sources: Pressed wood products (hardwood plywood wall paneling, particleboard, fiberboard) and furniture made with these pressed wood products. Urea-formaldehyde foam insulation (UFFI). Combustion sources and environmental tobacco smoke. Durable press drapes, other textiles, and glues.

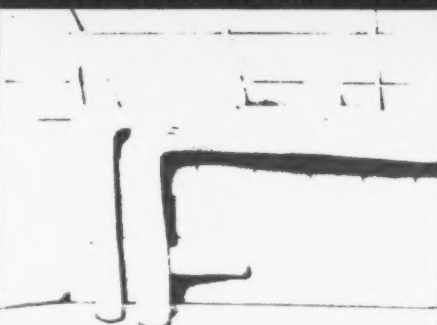
Health Effects: Eye, nose, and throat irritation; wheezing and coughing; fatigue; skin rash; severe allergic reactions. May cause cancer. May also cause other effects listed under "organic gases."

Levels in Homes: Average concentrations in older homes without UFFI are generally well below 0.1 (ppm). In homes with significant amounts of new pressed wood products, levels can be greater than 0.3 ppm.

Steps to Reduce Exposure:

- Use "exterior grade" pressed wood products (lower-emitting because they contain phenol resins, not urea resins).
- Use air conditioning and dehumidifiers to maintain moderate temperature and reduce humidity levels.
- Increase ventilation, particularly after bringing new sources of formaldehyde into the home.

REFERENCE GUIDE TO MAJOR INDOOR AIR POLLUTANTS IN THE HOME

**PESTICIDES**

Sources: Products used to kill household pests (insecticides and termiticides). Also, products used on lawns and gardens that drift or are tracked inside the house.

Health Effects: Irritation to eye, nose, and throat; damage to central nervous system and kidney; cancer.

Levels in Homes: Preliminary research shows widespread presence of pesticide residues in homes.

Steps to Reduce Exposure:

- Use strictly according to manufacturer's directions.
- Mix or dilute outdoors.
- Apply only in recommended quantities.
- Take plants or pets outside, where possible. Increase ventilation when using indoors.
- Use non-chemical methods of pest control where possible.
- If you use a pest control company, select it carefully.
- Do not store unneeded pesticides inside home; dispose of unwanted containers safely.
- Store clothes with moth repellents in separately ventilated areas, if possible.
- Keep indoor spaces clean and well-ventilated in order to eliminate or minimize use of air fresheners.

ASBESTOS

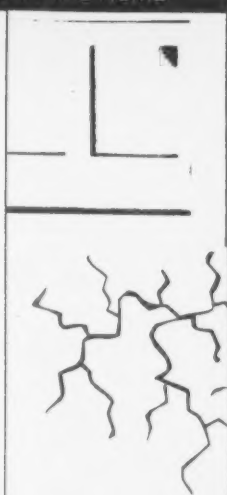
Sources: Deteriorating or damaged insulation, fireproofing, or acoustical materials.

Health Effects: No immediate symptoms. Chest and abdominal cancers and lung diseases. Smokers are at higher risk of developing asbestos-induced lung cancer.

Levels in Homes: Elevated levels can occur in homes where asbestos-containing materials are damaged or disturbed.

Steps to Reduce Exposure:

- Seek professional advice to identify potential asbestos problems. (Do not disturb materials suspected of containing asbestos.)
- Use trained and qualified contractors for control measures that may disturb asbestos and for cleanup.
- Follow proper procedures in replacing woodstove door gaskets that may contain asbestos.

**LEAD**

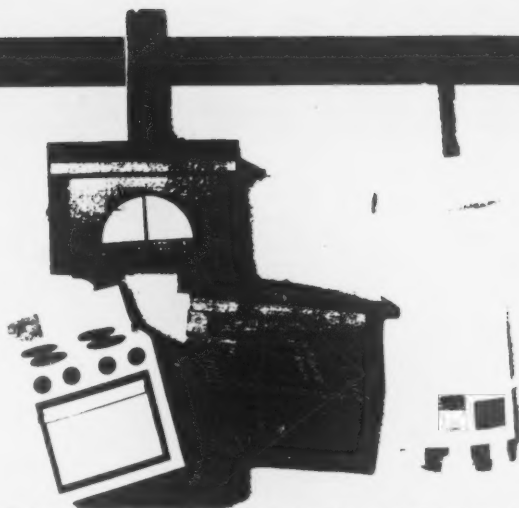
Sources: Automobile exhaust. Sanding or open-flame burning of lead-based paint. Activities involving lead solder.

Health Effects: Impaired mental and physical development in both fetuses and young children. Decreased coordination and mental abilities; damage to kidneys and nervous system, and red blood cells. May increase high blood pressure.

Levels in Homes: Lead dust levels 10 to 100 times greater in homes where sanding or open-flame burning of lead-based paints has occurred.

Steps to Reduce Exposure:

- If you suspect that paint you are removing may contain lead, have it tested.
- Leave lead-based paint undisturbed. Do not sand or burn off.
- Cover lead-based paint with wallpaper or other building material. Replace moldings and other woodwork or have them removed and chemically treated off-site.
- Use well-ventilated areas for hobby and house maintenance activities involving lead. Consider using "no-lead" solder.
- If lead exposure is suspected, consult your health department about appropriate removal and clean-up procedures and have your blood lead levels tested.
- Have your drinking water tested for lead.



(continued from page 14)
and benzo(a)pyrene, both of which can cause cancer, attach to small particles that are inhaled and then carried deep into the lung.

Reducing Exposure to Combustion Products in Homes

■ **Take special precautions when operating fuel-burning, unvented space heaters.** Consider potential effects of indoor air pollution when you decide to use an unvented kerosene or gas space heater. Follow the manufacturer's directions, especially instructions on the proper fuel and keeping the heater properly adjusted. A persistent yellow-tipped flame is generally an indicator of maladjustment and increased pollutant emissions. While a space heater is in use, open a door from the room where the heater is located to the rest of the house and open a window slightly.

■ **Install and use exhaust fans over gas cooking stoves and ranges and keep the burners properly adjusted.**

Using a stove hood with a fan vented to the outdoors can greatly reduce exposure to pollutants during cooking. Improper adjustment, often indicated by a persistent yellow-tipped flame, can result in increased pollutant emissions. Ask your gas company to adjust the burner so that the flame tip is blue. If you purchase a new gas stove or range, consider buying one with pilotless ignition because they do not have a pilot light that burns continuously. Never use a gas stove to heat your home and always make certain the flue in your gas fireplace is open when the fireplace is in use.

■ **Keep woodstove emissions to a minimum.** Choose properly-sized new stoves that are certified as meeting EPA emission standards. Make certain that doors in old woodstoves are tight-fitting. Use aged or cured (dried) wood only, and follow the manufacturer's directions for starting, stoking, and putting out the fire in woodstoves. Chemicals are used to pressure-treat wood; such wood should never be

burned indoors. (Because some old gaskets in woodstove doors contain asbestos, when replacing gaskets refer to the instructions in the EPA and CPSC booklet, *Asbestos in Homes*, to avoid creating an asbestos problem. New gaskets are made of fiberglass.)

■ **Have central air handling systems — including furnaces, flues, and chimneys — inspected annually and promptly repair cracks or damaged parts.** Blocked, leaking, or damaged chimneys or flues can release harmful combustion gases and particles and even fatal concentrations of carbon monoxide. Strictly follow all service and maintenance procedures recommended by the manufacturer, including those that tell you how frequently to change the filters. If manufacturer's instructions are not readily available, change filters once every month or two during periods of use. Proper maintenance is important even for new furnaces, because they can also corrode and leak combustion gases, including carbon monoxide.

HOUSEHOLD PRODUCTS

Organic chemicals are widely used as ingredients in household products because of their many useful characteristics, such as the ability to dissolve substances and evaporate quickly. Paints, varnishes, and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing, and hobby products. Fuels are made up of organic chemicals. All of these products can release organic compounds while you are using them, and, to some degree, when they are stored.

In research conducted by EPA, called the Total Exposure Assessment Methodology (TEAM) studies, levels of about a dozen common organic pollutants were found to be 2 to 5 times higher inside homes than outside, regardless of whether the homes were located in rural or highly industrial areas. Additional TEAM studies indicate that while people are using products containing organic chemicals, they can expose themselves and others to very high pollutant levels and elevated concentrations can persist in the air long after the activity is completed. Three out of four specific organic compounds mentioned later in this booklet — benzene, perchloroethylene, and paradichlorobenzene — are among the most prevalent organic compounds identified by the TEAM studies. The fourth organic compound, methylene chloride, is used widely in consumer goods.

Health Effects

The ability of organic chemicals to cause health effects varies greatly — from



those that are highly toxic, to those with no known health effect. Eye and respiratory tract irritation, headaches, dizziness, visual disorders, and memory impairment are among the immediate symptoms that some people have experienced soon after exposure to some organics. At present, not much is known about what health effects occur from the levels of organics found in homes. Many organic compounds are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans.

Organize Safe Collection Days for Household Hazardous Wastes

The League of Women Voters of Massachusetts makes available a video and kit of materials giving tips on how to set up household hazardous waste collection days. (Write to the League of Women Voters of Massachusetts, 8 Winter Street, Boston, MA 02108, for a flyer and order form.) Another source of information is EPA's publication entitled *Household Hazardous Waste: A Bibliography of Useful References and List of State Experts*. To order copies, call EPA's RCRA/Superfund hotline at 1-800-424-9346.

Reducing Exposure to Household Chemicals

■ **Follow label instructions carefully.** Products often have warnings aimed at reducing exposure to the user. For example, if a label says to use the product in a "well-ventilated" area, go outdoors or in areas equipped with an exhaust fan to use the product, if possible. Otherwise, open windows to provide the maximum amount of outdoor air possible.

■ **Throw away partially full containers of old or unneeded chemicals safely.** Because gases can leak even from closed containers, this single step could do much to lower concentrations of organic chemicals in your home. (Be sure that materials you decide to keep are stored not only in a well-ventilated area but are also safely out of reach of children.) *Do not simply toss these unwanted products in the garbage can.* Find out if your local government or any organization in your community sponsors special days for the collection of toxic household wastes. If such days are available, use them to dispose of the unwanted containers safely. If no such collection days are available, think about organizing one.

■ **Buy limited quantities.** In the future, if you use pro-

ducts only occasionally or seasonally, such as paints, paint strippers, and kerosene for space heaters or gasoline for lawn mowers, buy only as much as you will use right away.

■ **Keep exposure to emissions from products containing methylene chloride to a minimum.** Consumer products that contain methylene chloride include paint strippers, adhesive removers, aerosol spray paints, and pesticide "bombs." Methylene chloride is known to cause cancer in animals. Also, methylene chloride is converted to carbon monoxide in the body and can cause symptoms associated with exposure to carbon monoxide. Carefully read the labels containing health hazard information and cautions on the proper use of these products. Use methylene chloride-containing products outdoors when possible; use indoors with as much ventilation as possible.

■ **Keep exposure to benzene to a minimum.** Benzene is a known human carcinogen. The main indoor sources of this chemical are environmental tobacco smoke, stored fuels and paint supplies, and automobile emissions in attached garages. Actions which will reduce benzene exposure include eliminating smoking within the home, providing for

maximum ventilation during painting, and discarding paint supplies and special fuels that will not be used immediately.

■ **Keep exposure to perchloroethylene emissions from newly dry cleaned materials to a minimum.** Perchloroethylene is the chemical most widely used in dry cleaning. In laboratory studies, it has been shown to cause cancer in animals. Recent studies indicate that people breathe low levels of this chemical both in homes where dry cleaned goods are stored and as they wear dry cleaned clothing. Dry cleaners recapture the perchloroethylene during the dry cleaning process so they can save money by reusing it and they remove more of the chemical during the pressing and finishing processes. Some dry cleaners, however, do not remove as much perchloroethylene as possible all of the time.

Taking steps to minimize your exposure to this chemical is prudent. If dry cleaned goods have a strong chemical odor when you pick them up, do not accept them until they have been properly dried. If goods with a chemical odor are returned to you on subsequent visits, try a different dry cleaner.



Attached garages or workplace areas where petroleum products and old painting and cleaning supplies are stored can be major sources of organic air pollutants.

FORMALDEHYDE

Formaldehyde is an important chemical used widely by industry to manufacture building materials and numerous household products. It is also a by-product of combustion and certain other natural processes. Thus it may be present in substantial concentrations both indoors and outdoors.

Sources of formaldehyde in the home include smoking, household products, and the use of unvented, fuel-burning appliances, like gas stoves or kerosene space heaters. Formaldehyde, by itself or in combination with other chemicals, serves a number of purposes in manufactured products. For example, it is used to add permanent press qualities to clothing and draperies, as a component of glues and adhesives, and as a preservative in some paints and coating products.

In homes, the most significant sources of formaldehyde are likely to be pressed wood products made using adhesives that contain urea-formaldehyde (UF) resins. Pressed wood products made for indoor use include: *particleboard* (used as subflooring and shelving and in cabinetry and furniture); *hardwood plywood paneling* (used for decorative wall covering and used in cabinets and furniture); and *medium density fiberboard* (used for drawer fronts, cabinet doors, and furniture tops). Medium density fiberboard contains a higher resin-to-wood ratio than any other UF pressed wood product, and is generally recognized as being the highest formaldehyde-emitting pressed wood product.

Other pressed wood products, like softwood plywood

and flake or oriented strand-board, are produced for exterior construction use and contain the dark, or reddish-black colored phenol-formaldehyde (PF) resin. Although formaldehyde is present in both types of resins, pressed woods that contain PF resin generally emit formaldehyde at considerably lower rates than those containing UF resin.

Since 1985, HUD has permitted only the use of plywood and particleboard that conform to specified formaldehyde emission limits in the construction of prefabricated and mobile homes. In the past, some of these homes had elevated levels of formaldehyde because of the large amount of high-emitting pressed wood products used in their construction and because of their relatively small interior space.

The rate at which products

like pressed wood or textiles release formaldehyde emissions can change. Formaldehyde emissions will generally decrease as products age. When the products are new, high indoor temperatures or humidity can cause increased release of formaldehyde from these products.

During the 1970s, many homeowners had urea-formaldehyde foam insulation (UFFI) installed in the wall cavities of their homes as an energy conservation measure. However, many of these homes were found to have relatively high indoor concentrations of formaldehyde soon after the UFFI installation. Few, if any, homes are now being insulated with this product. Studies show that formaldehyde emissions from UFFI decline with time; therefore, homes in which UFFI was installed many years ago are unlikely to

have high levels of formaldehyde now unless the insulation is damp and there are cracks or openings in interior walls that expose the foam.

Health Effects of Formaldehyde

Formaldehyde, a colorless, pungent-smelling gas, can cause watery eyes, burning sensations in the eyes and throat, nausea, and difficulty in breathing in some humans exposed at elevated levels (above 0.1 parts per million). High concentrations may trigger asthma attacks in people with asthma. There is some evidence that some people can develop chemical sensitivity after exposure to formaldehyde. Formaldehyde has also been shown to cause cancer in animals and may cause cancer in humans.





Pressed wood products made with phenol-formaldehyde are sometimes stamped to indicate they are suitable for exterior use. In general, phenol-formaldehyde wood products emit less formaldehyde than wood products made with urea-formaldehyde.

Reducing Exposure to Formaldehyde in Homes

■ **Ask about the formaldehyde content of pressed wood products, including building materials, cabinetry, and furniture before you purchase them.** If you experience adverse reactions to formaldehyde, you may want to avoid the use of pressed wood products and other formaldehyde-emitting goods. Even if you do not experience such reactions, you may wish to reduce your exposure as much as possible by purchasing exterior-grade products, which emit less formaldehyde. For further information on formaldehyde and consumer products, call the EPA Toxic Substance Control Act (TSCA) assistance line (202-554-1404).

Some studies suggest that coating pressed wood products with polyurethane may reduce formaldehyde emissions for some period of time. To be effective, any such coating must cover all surfaces and edges and remain intact. Increase the ventilation and carefully

follow the manufacturer's instructions while applying these coatings. (If you are sensitive to formaldehyde, check the label contents before purchasing coating products to avoid buying formaldehyde-containing products, as they will emit the chemical for a short time after application.)

■ **Maintain moderate temperature and humidity levels and provide adequate ventilation.** The rate at which formaldehyde is released is accelerated by heat and may also depend somewhat on the humidity level. Therefore, the use of dehumidifiers and air conditioning to control humidity and to maintain a moderate temperature can help reduce formaldehyde emissions.

(Drain and clean dehumidifier collection trays frequently so that they do not become a breeding ground for microorganisms.) Increasing the rate of ventilation in your home will also help in reducing formaldehyde levels.

PESTICIDES

According to an EPA survey, 9 out of 10 U.S. households use pesticides. One study by EPA suggests that 80-90 percent of most people's exposure to pesticides in the air occurs indoors and that measurable levels of up to a dozen pesticides have been found in the air inside homes. The amount of pesticides found in homes appears to be greater than can be explained by recent pesticide use in those households; other possible sources include contaminated soil or dust that floats or is tracked in from outside, stored pesticide containers, and household surfaces that collect and then release the pesticides.

EPA registers pesticides for use and requires manufacturers to put information on the label about when and how to use the pesticide. It is important to remember that the "-cide" in pesticides means "to kill." These products are *dangerous if not used properly.*

In addition to the active ingredient, pesticides are also made up of ingredients which are used to carry the active agent. These carrier agents are called "inerts" in pesticides because they are not toxic to the targeted pest; nevertheless, some "inerts" are capable of causing health problems. For example, methylene chloride,

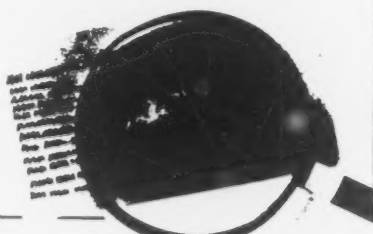
discussed under "Household Products," is used as an "inert."

Pesticides used in and around the home include products to control insects (insecticides), termites (termicides), rodents (rodenticides), and fungi (fungicides). They are sold as sprays, liquids, sticks, powders, crystals, balls, and foggers or "bombs."

Chlordane, and three other related termiticides (the "cyclodienes") — heptachlor, aldrin, and dieldrin — deserve special attention because of their ability to remain active for long periods of time. In recent studies, air samples taken in homes soon after well applied termiticide treatments contained residues of these chemicals. As a result of these studies, EPA has taken a series of actions that led to the removal of these chemicals from the marketplace. All use of aldrin and dieldrin has been banned, while chlordane and heptachlor cannot be used until an application method that will not result in any measurable exposure to household occupants is successfully developed. Alternative termiticides are currently available, and EPA anticipates that manufacturers will soon apply to register others.

Health Effects From Pesticides

Both the active and "inert" ingredients in pesticides can



be organic compounds; therefore, both can add to the levels of airborne organics inside homes. Both types of ingredients can cause the effects discussed in this booklet under "Household Products." However, there is little understanding at present about what concentrations are necessary to produce these effects.

Exposure to high levels of cyclodienes, commonly associated with misapplication, has produced various symptoms, including headaches, dizziness, muscle twitching, weakness, tingling sensations, and nausea. In addition, EPA is concerned that cyclodienes might cause long-term damage to the liver and the central nervous system, as well as increased risk of cancer.

Reducing Exposure to Pesticides in Homes

■ **Read the label and follow the directions.** It is illegal to use any pesticide in any manner inconsistent with the directions on its label. Unless you have had special training and are certified, never use a pesticide that is restricted to use by state-certified pest control operators. Such pesticides are simply too dangerous for application by a non-certified person. Use only the pesticides approved for use by the general public and then only in recommended amounts; increasing the amount does not offer more protection against pests and can be harmful to you and your plants or pets.

■ **Use in well-ventilated areas.** Open windows when applying pesticides. Mix or dilute pesticides outdoors or in a well-ventilated area and only in the amounts that will

be immediately needed. If possible, take plants or pets outside when applying pesticides to them.

■ **Use alternative non-chemical methods of pest control.** Since pesticides can be found far from the site of their original application, it is prudent to reduce the use of chemical pesticides outdoors as well as indoors. Depending on the site and pest to be controlled, one or more of the following steps can be effective: use of biological pesticides, such as *Bacillus thuringiensis* for the control of gypsy moths; selection of disease-resistant plants; and frequent washing of indoor plants or pets. Termite damage can be reduced or prevented by making certain that wooden building materials do not come into direct contact with the soil and by storing firewood away from the home. By appropriately fertilizing, watering, and aerating lawns, the need for chemical pesticide treatments of lawns can be dramatically reduced.

■ **If you decide to use a pest control company, choose one carefully.** Ask for an inspection of your home and get a written control program for evaluation before you sign a contract. The control program should list specific names of pests to be controlled and chemicals to be used; it should also reflect any of your safety concerns. Insist on a proven record of competence and customer satisfaction.

■ **Dispose of unwanted pesticides safely.** If you have unused or partially used pesticide containers you want to get rid of, dispose of them according to the directions on the label or on special household hazardous waste collection days. If



There are simple steps people can take to prevent, reduce, or control pest infestations. Such techniques can become part of an overall pest management program (sometimes called "integrated" pest management) that relies on many techniques, not just chemicals.

there are no such collection days in your community, work with others to organize them. (See suggestion under "Household Products.")

■ **Keep exposure to moth repellents to a minimum.** One pesticide often found in the home is paradichlorobenzene, a commonly used active ingredient in moth repellents. This chemical is known to cause cancer in animals, but substantial scientific uncertainty exists over what may be the effects, if any, of long-term human exposure to paradichlorobenzene. EPA requires that products containing paradichlorobenzene bear warnings such as "avoid breathing vapors" to warn users of potential short-term toxic effects. Where possible, paradichlorobenzene, and items to be protected against moths, should be placed in trunks or other containers that can be stored in areas that are separately ventilated from the home, such as attics and detached garages.

Paradichlorobenzene is also the key active ingredient in many air fresheners (in fact, some labels for moth repellents recommend that these same products be used as air fresheners or deodorants). Proper ventilation and basic household cleanliness will go a long way toward preventing unpleasant odors — thereby reducing or eliminating the need for air fresheners.

■ **Call the National Pesticide Telecommunications Network (NPTN).** EPA sponsors the NPTN (1-800-858-PEST) to answer your questions about pesticides and to provide EPA publications on pesticides. Two such EPA publications are *A Citizen's Guide to Pesticides and Termiticides Consumer Information*.

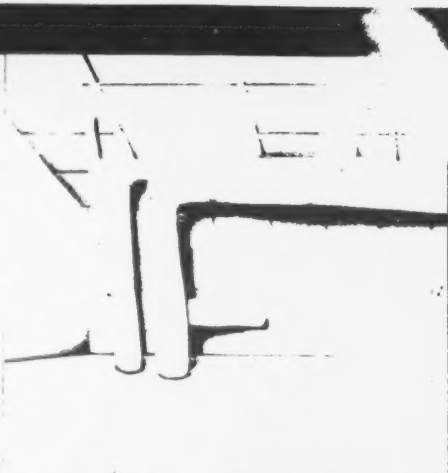
ASBESTOS

Asbestos is a mineral fiber that has been used commonly in a variety of building construction materials for insulation and as a fire-retardant. EPA and CPSC have banned several asbestos products. Manufacturers have also voluntarily limited uses of asbestos. Today asbestos is most commonly found in older homes in pipe and furnace insulation materials, asbestos shingles, millboard, textured paints and other coating materials, and floor tiles.

Elevated concentrations of airborne asbestos can occur after asbestos-containing materials are disturbed by cutting, sanding, or other remodeling activities. Improper attempts to remove these materials can release asbestos fibers into the air in homes — increasing asbestos levels and endangering people living in those homes.

Health Effects of Asbestos

The most dangerous asbestos fibers are too small to be visible. After they are inhaled, they can remain and accumulate in the lungs. Asbestos can cause lung cancer, mesothelioma (a cancer of the chest and abdominal linings) and asbestosis (irreversible lung scarring that can be fatal). Symptoms of these diseases do not show up until many years after exposure began. Most people with asbestos-related diseases were exposed to elevated concentrations on the job; some developed disease from exposure to clothing and equipment brought home from job sites.



Reducing Exposure to Asbestos in Homes

■ **Learn how asbestos problems are created in homes.** Read the booklet, *Asbestos in the Home*, issued by CPSC and EPA. To order a copy of this publication send a postcard to Asbestos in the Home, Washington, DC 20207.

■ **If you think your home may have an asbestos problem, ask a trained professional to help determine whether your home has asbestos-containing materials and whether those materials are damaged or deteriorating.** Look to trained contractors, the manufacturer or installer of particular products or

materials in your home, your state asbestos program (if there is one), and your state health department for information on how to identify and remedy asbestos problems in your home.

■ **Do not cut, rip, or sand asbestos-containing materials.** Leave undamaged materials alone and, to the extent possible, prevent them from being disturbed, damaged, or touched. Inspect periodically for damage or deterioration.

■ **When you need to remove or clean up asbestos, use a professional, trained contractor.** Select a contractor only after careful discussion of the problems in your home and the steps the contractor will take to clean up or remove them. Consider the option of sealing off the materials instead of removing them. Call the EPA TSCA assistance line (202-554-1404) to find out whether your state has a training and certification program for asbestos removal contractors and for information on EPA's asbestos programs.

Asbestos in the Home



LEAD

Lead has long been recognized as a harmful environmental pollutant. There are many ways in which humans are exposed to lead, including air, drinking water, food, and contaminated soil and dust. Airborne lead enters the body when an individual breathes lead particles or swallows lead dust once it has settled. Until recently, the most important airborne source of lead was automobile exhaust.

Lead-based paint has long been recognized as a hazard to children who eat lead-containing paint chips. A 1988 National Institute of Building Sciences (NIBS) Task Force report found that harmful exposures to lead can be created when lead-based paint is removed from surfaces by sanding or open-flame burning. The NIBS Task Force called for development of better and safer techniques to remove lead-

based paints and effective clean-up methods.

High concentrations of airborne lead particles in homes can also result from the lead dust from outdoor sources, contaminated soil tracked inside, use of lead in activities such as soldering, electronics repair, and stained glass art work.

Health Effects of Exposure to Lead

Lead is toxic to many organs within the body at both low and high concentrations. Lead is capable of causing serious damage to the brain, kidneys, peripheral nervous system (the sense organs and nerves controlling the body), and red blood cells. Even low levels of lead may increase high blood pressure in adults.

Fetuses, infants, and children are more vulnerable to lead exposure than adults since lead is more easily absorbed into growing bodies, and the tissues of small children are more sen-

Do not remove lead-based paint by scraping, sanding, or burning it off. Such removal techniques can result in lead levels in the air that are 10 to 100 times higher than normal.



sitive to the damaging effects of lead. In addition, an equal concentration of lead is more damaging because of a child's smaller body weight. Children may also have higher exposures since they are more likely to get lead dust on their hands and then put their fingers or other lead-contaminated objects into their mouths. The effects of lead exposure on fetuses and young children include delays in physical and mental development, lower IQ levels, shortened attention spans, and increased behavioral problems.

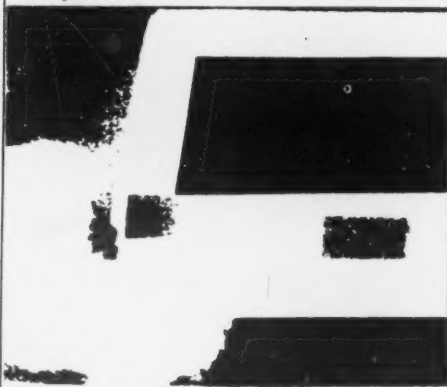
Ways to Reduce Exposure to Lead

■ **If you suspect that paint in your home contains lead, have it tested.** It has been estimated that lead paint was used in about two-thirds of the houses built before 1940; one-third of the houses built from 1940 to 1960; and some housing built since 1960. Consult your state health or housing department for suggestions on which private laboratories or public agencies may be able to help test your home for lead in paint.

■ **Leave lead-based paint undisturbed if it is in good condition and there is little likelihood that it will be eaten by children — do not sand or burn off paint that may contain lead.** Ordinary household cleaning methods are ineffective at removing lead dust produced by sanding and burning; vacuuming does not sufficiently reduce lead dust levels because the particles pass through the filtering system in ordinary vacuums. Repainting areas covered with lead-based paint is not recommended because steps to prepare the surface area, such as sanding or removing cracked paint, produce lead dust.

If paint is cracked or peeling, cover with wallpaper or some other building material or replace the painted surface. Also, consider having painted woodwork such as doors and molding taken out of the house and sent off-site for chemical removal.

If on-site removal of lead-based paint cannot be avoided, then everyone not involved in doing the removal should leave the building during the period that removal takes place — no matter whether it involves



Since 1975, there has been a 95 percent reduction in the use of lead in gasoline due to the EPA lead-in-gasoline phasedown program and the replacement of older cars with newer cars that require the use of unleaded gasoline.

sanding, burning, or chemical stripping. Workers should be protected and thorough clean-up should follow removal.

• People who may have been exposed to lead dust recently should have the lead levels in their blood tested by their doctor or local health department. If exposure occurred some time previously, a blood test may not be a reliable indicator of exposure and it may be advisable for exposed children or adults to have neurological tests done. If either test shows lead exposure has occurred, follow the advice of your doctor or health department.

• Keep surface areas clean. Frequent cleaning of smooth surfaces, especially food preparation areas, with a wet cloth or mop can reduce the amount of lead dust that drifts or is tracked in from outdoors. However, lead dust will remain in carpeting and on furnishings.

• Choose well-ventilated areas to engage in activities that involve the use of lead. As with other activities, increasing ventilation can reduce potential health effects by reducing the concentrations of indoor air pollutants. Consider using "no-lead" solder.

• Have the drinking water in your home tested for lead. Homes most likely to have high lead levels in their water are those with lead-soldered plumbing that is less than 5 years old or those that have water service connections or interior plumbing made of lead. Send for the EPA pamphlet, *Lead and Your Drinking Water*, for more information about what you can do if you have lead in your drinking water.



TO KEEP IN MIND IF YOU ARE BUILDING A NEW HOME

Building a new home provides the opportunity for preventing indoor air problems. However, it can also bring exposure to higher levels of indoor air contaminants if careful attention is not given to potential pollution sources and the air exchange rate.

Express your concerns about indoor air quality to your architect or builder and enlist his or her cooperation in taking measures to provide good indoor air quality. Talk both about purchasing building materials and furnishings that are low-emitting and about providing an adequate amount of ventilation.

The American Society of Heating, Refrigerating, and Air Conditioning Engineers recommends a ventilation rate of 0.35 ach (air changes per hour) for new homes, and some new homes are built to even tighter specifications. Particular care should be given in such homes to preventing the build-up of indoor air pollutants to high levels.

Here are a few important actions that can make a difference:

• Use radon resistant construction techniques. Obtain a copy of the EPA booklet,



Radon Reduction in New Construction: An Interim Guide, from your state radon or health agency, your state homebuilders' association, your EPA regional office, or the EPA Public Information Center.

• Choose building materials and furnishings that will keep indoor air pollution to a minimum. There are many actions a homeowner can take to select products that will prevent indoor air problems from occurring — a couple of them are mentioned here. First, use exterior-grade pressed wood products made with phenol-formaldehyde in floors, cabinetry, and wall surfaces. Or, as an alternative, consider using solid wood products. Secondly, do not permanently adhere carpets directly to cement floors because cement floors tend to be cold and moisture condenses on the carpet,

providing a place for mold and dust mites to grow. Also, carpets laid in this manner do not dry thoroughly if they get wet.

• Provide proper drainage and seal foundations in new construction. Air that enters the home through the foundation can contain more moisture than is generated from all occupant activities.

• Become familiar with how heat recovery ventilators (air-to-air heat exchangers) work and consider installing one. A whole-house heat recovery ventilation system permits occupants to enjoy the air quality benefits of drawing more outdoor air into the home while reducing the costs of heating or cooling this air.

• Install exterior-vented air ducts into woodstove fireboxes and near fireplaces. The supplementary air supply from these ducts will provide adequate oxygen for complete combustion, minimize infiltration of cold outside air into the rest of the house, and prevent backdrafts from bringing combustion products back down the chimney. Do not close the duct until all embers are extinguished.

DOES YOUR OFFICE SUFFER FROM "SICK BUILDING SYNDROME?"

Indoor air quality problems are not limited to homes. In fact, many office buildings have significant air pollution sources. In addition, these buildings may be inadequately ventilated. For example, mechanical ventilation systems may not be designed or operated to provide adequate amounts of outside air. Finally, people generally have less control over the indoor environment in their offices than they do in their homes.

Some indoor air pollutants in office environments pose long-term risks (for example, the cancer risk from asbestos). In recent years, however, there has been an increase in the incidence of immediate health problems related to indoor air pollutants in office environments.

HEALTH EFFECTS

A number of well-identified illnesses, such as Legionnaire's disease, asthma, hypersensitivity pneumonitis, and humidifier fever, have been directly traced to specific building problems. These are called *building-related illnesses*. Most of these diseases can be treated; nevertheless some can pose serious risks to some individuals.

Frequently, however, a significant number of building occupants experience symptoms that do not fit the pattern of any particular illness and are difficult to trace to any specific source. This phenomenon has been labeled *sick building syndrome*. People may complain of one or more of the following symptoms: dry or burning mucous membranes in the nose, eyes, and throat; sneezing, stuffy or runny nose; fatigue or lethargy; headache, dizziness, nausea,

irritability, and forgetfulness. Poor lighting, noise, vibration, thermal discomfort, and psychological stress may also cause, or contribute to, these symptoms.

There is no single manner in which these health problems appear. In some cases, problems begin as workers enter their offices and diminish as workers leave; other times, symptoms continue until the illness is treated. Sometimes there are outbreaks of illness among many workers in a single building; in other cases, health symptoms show up only in individual workers.

There are usually some occupant complaints about health and comfort in new buildings. In fact, the ventilation guidelines for indoor air quality set forth by the American Society of Heating, Refrigerating and Air Conditioning Engineers are intended to satisfy 80 percent of a building's occupants.

In the opinion of some World Health Organization experts, up to 30 percent of new or remodelled commercial buildings may have unusually high rates of health and comfort complaints from occupants that may potentially be related to indoor air quality.

WHAT CAUSES INDOOR AIR PROBLEMS IN OFFICES?

Three major reasons for poor indoor air quality in office buildings are the presence of indoor air pollution sources, poorly designed, maintained, or operated ventilation systems, and uses of the building that were unanticipated or poorly planned for when the building was designed or renovated.

Sources of Office Air Pollution

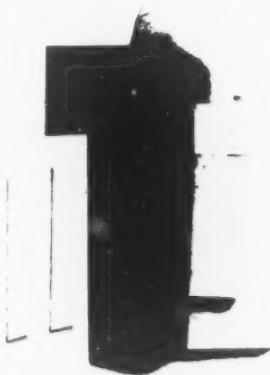
As with homes, the most important factor influencing indoor air quality is the presence of pollutant sources. Commonly found office pollutants and their sources include environmental tobacco smoke; asbestos from insulating and fire-retardant building supplies; formaldehyde from pressed wood products; other organics from building materials, carpeting, and other office furnishings, cleaning materials and activities, restroom air fresheners, paints, adhesives, copying machines, and photography and print shops; biological contaminants from dirty ventilation systems or water-damaged walls, ceilings, and carpets;

and pesticides from pest management practices.

Ventilation Systems

Mechanical ventilation systems in large buildings are designed and operated not only to heat and cool the air, but also to draw in and circulate outdoor air. When they are poorly designed, operated, or maintained, however, ventilation systems can contribute to indoor air problems in several ways.

For example, problems arise when, in an effort to save energy, ventilation systems are not used to bring in adequate amounts of outdoor air. Inadequate ventilation also occurs if the air supply and return vents within each room are blocked or placed in such a



way that outside air does not actually reach the breathing zone of building occupants. Improperly located outside air intake air vents can also bring in air contaminated with automobile and truck exhaust, boiler emissions, fumes from dumpsters, or air vented from restrooms. Finally, ventilation systems can be a source of indoor pollution themselves by spreading biological contaminants that have multiplied in cooling towers, humidifiers, dehumidifiers, air conditioners, or the inside surfaces of ventilation ductwork.

Use of the Building

Indoor air pollutants can be circulated from portions of the building used for specialized purposes, such as restaurants, print shops, and dry cleaning stores, into offices in the same building. Carbon monoxide and other components of automobile exhaust can be drawn from underground parking garages through stairwells and elevator shafts into office spaces.

In addition, buildings originally designed for one purpose may end up being converted to use as office

space. If not properly modified during building renovations, the room partitions and ventilation system can contribute to indoor air quality problems by restricting air recirculation or by providing an inadequate supply of outside air.

Role of a Building Inspection in Correcting Problems

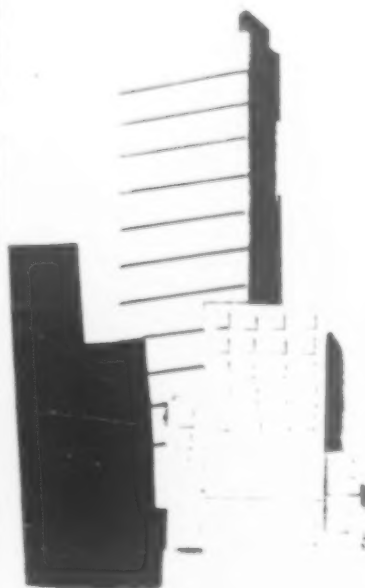
Frequently indoor air quality problems in large commercial buildings cannot be effectively identified or remedied without a comprehensive building investigation. These investigations may start with written questionnaires and telephone consultations in which building investigators assess the history of occupant symptoms and building operation procedures. In some cases, these inquiries may quickly uncover the problem and on-site visits are unnecessary.

More often, however, investigators will need to come to the building to conduct personal interviews with occupants, to look for possible sources of the problems, and to inspect the design and operation of the ventilation system and other building features. Because taking measurements of pollutants at the very low levels often found in office buildings is expensive and may not yield information useful in identifying problem sources, investigators may not take many measurements. The process of solving indoor air quality problems that result in health and comfort complaints can be a slow one, involving several trial solutions before successful remedial actions are identified.

WHAT TO DO IF YOU SUSPECT A PROBLEM

If you or others at your office are experiencing health or comfort problems that you suspect may be caused by indoor air pollution, you can do the following:

- Talk with your own physician and report your problems to the company physician, nurse, or health or biosafety officer so that they can be added to the record of health complaints;
- Talk with your supervisor, other workers, and union representatives to see if the problems are being experienced by others and urge that a record of reported health complaints be kept by management, if one has not already been established;
- Ask the building manager to consider hiring a commercial company that conducts building investigations to diagnose the problem or problems and to suggest solutions. Carefully select such companies on the basis of their experience in identifying and solving indoor air quality problems in non-industrial buildings;
- Call the National Institute for Occupational Health and Safety (NIOSH) for information on obtaining a health hazard evaluation of your office (1-800-35NIOSH);
- Call your state or local health department or air pollution control agency to talk over the symptoms and possible causes; and
- Work with others to establish a smoking policy that minimizes non-smoker exposure to environmental tobacco smoke.



WHERE TO GO FOR ADDITIONAL INFORMATION

FEDERAL AGENCIES

Federal agencies with indoor air responsibilities are listed below. Write to the addresses listed for the free materials mentioned earlier in this booklet.

U.S. Environmental Protection Agency (EPA)
Public Information Center
401 M Street SW
Washington, DC 20460

U.S. Consumer Product Safety Commission (CPSC)
Washington, DC 20207

*EPA Public Inquiry
Phone Numbers:*

Public Information Center
202-382-2080
Operates Monday to Friday
from 8 to 5:30 Eastern Standard Time (EST).

National Pesticides Telecommunications Network
National toll-free number:
1-800-858-PEST
In Texas:
806-743-3091
Operates 24 hours a day,
every day of the year. Provides information about pesticides to the general public and the medical, veterinary, and professional communities.

TSCA Assistance Information Service
202-554-1404
Operates Monday through Friday from 8:30 to 5 EST. Provides information on regulations under the Toxic Substances Control Act and on EPA's asbestos programs.

Safe Drinking Water Hotline
202-382-5533
Operates Monday through Friday from 8:30 to 4:30 EST. Provides information on regulations under the Safe Drinking Water Act, radon in drinking water, and a list of state drinking water offices.

RCRA/Superfund Hotline
National toll-free number:
1-800-424-9346
In Washington, DC:
202-382-3000
Operates Monday through Friday from 8:30 to 7:30 EST. Provides information on regulations under both the Resource Conservation and Recovery Act (including solid and hazardous waste issues) and the Superfund law.

*CPSC Public Inquiry
Phone Number:*

CPSC Toll-free Hotline
Product Safety
1-800-638-CPSC
Teletypewriter for the hearing impaired (outside Maryland)
1-800-638-8270
Teletypewriter for the hearing impaired (Maryland only)
1-800-492-8104
Recorded information is available 24 hours a day when calling from a touch-tone phone. Operators are on duty Monday to Friday from 10:30 to 4:00 EST to take complaints about unsafe consumer products.

CPSC Regional Offices:

Eastern Regional Center
6 World Trade Center
Vesey Street, 3rd Floor
New York, NY 10048
(212) 264-1125

Central Regional Center
230 South Dearborn Street,
Rm. 2944
Chicago, IL 60604
(312) 353-8260

Western Regional Center
555 Battery Street, Rm. 401
San Francisco, CA 94111
(415) 556-1816

EPA Regional Offices

Address inquiries to the
Indoor Air Contacts in the
EPA regional offices at the
following addresses:

Region**States in Region****Region 1**

EPA
John F. Kennedy
Federal Bldg.
Boston, MA 02203
617-565-3232

Connecticut, Maine,
Massachusetts, New
Hampshire, Rhode
Island, Vermont

Region 2

EPA
26 Federal Plaza
New York, NY 10278
212-264-2517

New Jersey, New York,
Puerto Rico, Virgin
Islands

Region 3

EPA
841 Chestnut Building
Philadelphia, PA 19107
215-597-9090
215-597-4084 (radon)

Delaware, District of
Columbia, Maryland,
Pennsylvania, Virginia,
West Virginia

Region 4

EPA
345 Courtland Street NE
Atlanta, GA 30365
404-347-2864

Alabama, Florida,
Georgia, Kentucky,
Mississippi, North
Carolina, South
Carolina, Tennessee

Region 5

EPA
230 S. Dearborn Street
Chicago, IL 60604
312-886-6054

Illinois, Indiana,
Michigan, Minnesota,
Ohio, Wisconsin

Region 6

EPA
Allied Bank Tower
1445 Ross Avenue
Dallas, TX 75202
214-655-7214

Arkansas, Louisiana,
Oklahoma, New Mexico,
Texas

Region 7

EPA
726 Minnesota Avenue
Kansas City, KS 66101
913-236-2893

Iowa, Kansas, Missouri,
Nebraska

Region 8

EPA
999 18th Street, Suite 500
Denver, CO 80202
303-293-1750

Colorado, Montana,
North Dakota, South
Dakota, Utah, Wyoming

Region 9

EPA
215 Fremont Street
San Francisco, CA 94105
415-974-8381

Arizona, California,
Hawaii, Nevada,
American Samoa,
Guam, Trust Territories
of the Pacific

Region 10

EPA
1200 Sixth Avenue
Seattle, WA 98101
206-442-4226

Alaska, Idaho, Oregon,
Washington



OTHER FEDERAL AGENCIES

Bonneville Power Administration
Portland, OR 97208

General Services Administration
18th and F Streets NW
Washington, DC 20450

Office of Conservation and Renewable Energy
U.S. Department of Energy
1000 Independence Avenue SW
Washington, DC 20585

National Institute for Occupational Safety and Health
Hazard Evaluations and Technical Assistance Branch (R-9)
Division of Surveillance, Hazard Evaluations and Field Studies
U.S. Department of Health and Human Services
4676 Columbia Parkway
Cincinnati, Ohio 45226

Office on Smoking and Health
U.S. Department of Health and Human Services
Rockville, MD 20857

Office on Energy and the Environment
U.S. Department of Housing and Urban Development
Washington, DC 20410

Occupational Safety and Health Administration
U.S. Department of Labor
200 Constitution Avenue NW
Washington, DC 20210

Tennessee Valley Authority
Industrial Hygiene Branch
328 Multipurpose Building
Muscle Shoals, AL 35660

STATE AND LOCAL AGENCIES

Your questions or concerns about indoor air problems can frequently be answered most readily by the government agencies in your state or local government. Responsibilities for indoor air quality issues are usually divided among many different agencies. You will often find that calling or writing the agencies responsible for health or air quality control is the best way to start getting information from your state or local government. The EPA publication, *Directory of State Indoor Air Contacts*, lists state agency contacts and is available at the EPA address listed on page 29.

PRIVATE SECTOR CONTACTS

Some of the private sector organizations that have information for the public on indoor air quality issues are:

American Institute of Architects
1350 New York Avenue NW
Washington, DC 20006

American Gas Association
1515 Wilson Boulevard
Arlington, VA 22209

Your local lung association or American Lung Association
1740 Broadway
New York, NY 10019

American Society of Heating, Refrigerating, and Air Conditioning Engineers
1791 Tullie Circle NE
Atlanta, GA 30329

Building Owners and Managers Association
1250 Eye Street NW, Suite 200
Washington, DC 20005

Consumer Federation of America
1424 16th Street NW, Suite 604
Washington, DC 20036

Edison Electric Institute
1111 19th Street NW
Washington, DC 20036

Safe Buildings Alliance
Metropolitan Square
655 15th Street, NW
Suite 12
Washington, DC 20005

National Association of Home Builders
Technology and Codes Department
15th and M Streets NW
Washington, DC 20005

World Health Organization
Publications Center
49 Sheridan Avenue
Albany, NY 12210

GLOSSARY



Acid aerosol. Acidic liquid or solid particles that are small enough to become airborne. High concentrations of acid aerosols can be irritating to the lungs and have been associated with some respiratory diseases, such as asthma.

Allergen. A substance capable of causing an allergic reaction because of an individual's sensitivity to that substance.

Allergic rhinitis. Inflammation of the mucous membranes in the nose.

Animal dander. Tiny scales of animal skin.

Breathing zone. The area of a room in which occupants breathe as they stand, sit, or lie down.

Building-related illness. Term that refers to a discrete, identifiable disease or illness. Can be traced to a specific pollutant or source within a building. (Contrast with "Sick building syndrome.")

Chemical Sensitivity. Evidence suggests that some people

can develop health problems characterized by effects such as dizziness, eye and throat irritation, chest tightness, and nasal congestion that appear whenever they are exposed to certain chemicals. People may react to even trace amounts of chemicals to which they have become "sensitized."

Fungi. Any of a group of parasitic lower plants that lack chlorophyll, including molds and mildews.

Humidifier fever. A respiratory illness that may be caused by exposure to toxins from microorganisms found in wet or moist areas in humidifiers and air conditioners. Also called air conditioner or ventilation fever.

Hypersensitivity pneumonitis.

A group of respiratory diseases, including humidifier fever, that involve inflammation of the lungs. Most forms of hypersensitivity pneumonitis are thought to be caused by an allergic reaction triggered by repeated exposures to

biological contaminants. Humidifier fever may be an exception, distinguished from other forms of pneumonitis by the fact that it does not appear to involve an allergic reaction.

Organic compounds. Chemicals that contain carbon. Volatile organic compounds vaporize at room temperature and pressure. They are found in many indoor sources, including many common household products and building materials.

Picocurie. A unit for measuring radioactivity, often expressed as picocuries per liter of air.

Polycyclic aromatic hydrocarbons. A group of organic compounds. Some are known to be potent human carcinogens.

Pressed wood products. A group of materials used in building and furniture construction that are made from wood veneers, particles, or fibers bonded together with an adhesive under heat and pressure.

Radon and radon decay products. Radon is a radioactive gas formed in the decay of uranium. The radon decay products (also called radon daughters or progeny) are particles that can be breathed into the lung where they continue to release radiation as they further decay.

Sick building syndrome. Term that refers to a set of symptoms that affect a number of building occupants during the time they spend in the building and diminish or go away during periods when they leave the building. Cannot be traced to specific pollutants or sources within the building. (Contrast with "Building-related illness.")

Ventilation rate. The rate at which outside air enters and leaves a building. Expressed in one of two ways: the number of changes of outside air per unit of time (air changes per hour, or "ach") or the rate at which a volume of outside air enters per unit of time (cubic feet per minute, or "cfm").

Information provided in this booklet is based upon current scientific and technical understanding of the issues presented and is reflective of the jurisdictional boundaries established by the statutes governing the co-authoring agencies. Following the advice given will not necessarily provide complete protection in all situations or against all health hazards that may be caused by indoor air pollution.

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PROTOCOLS TO IMPROVE INDOOR ENVIRONMENTAL QUALITY IN NEW CONSTRUCTION

H. Levin

ABSTRACT

Practical procedures for identifying, evaluating and controlling potential sources of indoor air pollution have been developed for use in large, commercial building projects, covering every phase from site selection and design through construction and post-occupancy evaluation.

Site evaluation includes identification of on- and off-site air pollutant sources and the conditions that require their control. Design begins with evaluation of overall ventilation, lighting and thermal control schemes and includes systematic selection of building materials and furnishings. Construction procedures include provision of temporary ventilation, where required, to reduce levels of indoor air pollutants in the completed building. Modifications to furnishings and finish materials, where required, are incorporated in the construction documents issued to potential bidders.

Pre-occupancy assessment of ventilation system performance and indoor air quality are incorporated in the construction schedule and budget. Special ventilation system protocols are developed for the initial occupancy period. Air quality monitoring and subjective evaluation are used to guide the transition from special protocols to long-term, "normal" operation.

INTRODUCTION

Building sickness (also known as "tight building syndrome" and "sick building syndrome") has become increasingly common in new and newly remodelled buildings (Finnegan 1984; Stolwijk 1984). Additionally, a growing awareness of building sickness has increased the attention paid to occupant complaints of building-related irritation or illness. While the causes of the problems and the complaints associated with them are only partially understood, there is general agreement that a certain group of causal or circumstantial factors is frequently involved. These causal or circumstantial factors have been enumerated by many authors (Ammann 1986; Berglund et al 1984; Fanger and Valbjorn 1978; Molhave 1982, 1986; NAS 1981; Stolwijk 1984; Turiel 1979, 1985;). They include elevated air levels of numerous chemicals, particulate matter including biological aerosols, and inadequate ventilation (Goromoso 1968; Levin 1981).

Working with architects, engineers, interior designers, and building owners' representatives, we have developed practical procedures for identifying, evaluating and controlling potential sources of indoor pollution. These procedures, developed for use in large, commercial buildings, cover every phase from site selection and design through construction and post-occupancy evaluation. Many of the procedures have not been sufficiently investigated to confirm their effectiveness, but we believe that generally they reflect a consensus among professionals and researchers who work on indoor air quality (Collins 1985; Levin 1986; Sandia 1982).

Hal Levin is Research Specialist at the Center for Environmental Design Research, University of California, Berkeley, and he is a principal with Hal Levin & Associates, Santa Cruz, CA.

In a sense, many of the procedures described here are simply variations on normal professional design practices incorporating concern for indoor air quality. Most of the procedures are described from the perspective of the building design professions: architecture, engineering, and interior design. Some of the practices fall outside the direct control of the design professionals, but they can be recommended to building management, maintenance and operation personnel. It is also important that design professionals become aware of the operational considerations required to improve indoor environmental quality in order to improve building design (Levin 1986).

The major phases of a building project are divided in this paper as shown in Table 1.

SUGGESTED PROCEDURES

Project Planning Phase

Planning a building project involves programming; economic, space and functional feasibility studies; scheduling the project from design through occupancy; determining construction and long-term financing; and assembling the design team. Many of the factors affecting indoor air quality are determined by decisions made before the actual design process begins.

Programming. During the "programming phase," architect and client define the goals and objectives of the projected building, specify the spatial and functional requirements, and establish the criteria and standards to be used in evaluating alternative design proposals. Air quality and other indoor environmental performance standards can be explicitly set forth in programming.

During programming, occupant activities anticipated in the building should be identified in terms of their potential to generate indoor air pollutants or their sensitivity to indoor air pollutants. Industrial processes, laboratory activities, food preparation, printing, duplicating, copying, mailing, and other office-associated activities can be sources of significant indoor pollution. Architects can best choose air quality control methods for such functions when they are identified early in the project and adequate planning allows consideration of alternative control strategies. Space planning can separate incompatible functions, isolate pollution-generating activities, and buffer activities sensitive air pollution.

In many instances, details of the ultimate use cannot be determined prior to construction or occupancy, as in rental buildings. Therefore, provision must be made for a combination of flexible designs and limitations on occupant activities that will result in acceptable indoor air quality. Unused flexibility designed into a building results in an unnecessary expense, but inflexibility, eliminating some potential tenants, might have unacceptable economic consequences for a landlord or building owner. Some compromise is usually necessary. Specifying the acceptable types of activities and range of environmental control system requirements at the planning stage will increase the potential to accommodate both the owner's needs and the requirements for acceptable air quality.

Outline specifications are sometimes prepared during the planning stage to allow evaluation of the projected building's cost or value. Outline specifications prepared with conceptual design drawings should include air quality related performance criteria of the ventilation system, major materials, and furnishings. Consideration of indoor air quality at the earliest point in the process makes adequate consideration more likely during each phase of the project.

The Budget Process. It is important that indoor air quality be considered during the budget process. Failing to achieve acceptable indoor air quality in the completed building can have significant economic consequences. The architect (or other prime design professional) is responsible for designing within the client's budget and advising the client regarding the estimated cost of the project.

Architects' efforts to improve IAQ can be constrained by the reluctance of clients to commit the additional resources necessary. The important issues and considerations need to be articulated by the designer in order to allow the client to make informed decisions. Many building developers are not aware that early attention with front end expenditures can reduce or eliminate the negative economic consequences of post-occupancy IAQ problems.

The major budgetary considerations related to indoor air quality are (1) provision of adequate funds to acquire specialized services during design, construction, and initial occupancy, and (2) to provide sufficient time after the scheduled completion of construction to allow for thorough commissioning and testing of building performance.

Coordination of the Design Team. The architect serves as the lead designer who assembles the design team and orchestrates its work. Architects have ultimate responsibility for the design and for determining that the completed building fulfills the design intent. In order to fulfill his/her responsibilities, the lead design professional must obtain the services of specialized consultants appropriate to the particular project and to complement those of the architect's own staff. The design team normally consists of engineers, interior designers, specifications writers, specialized consultants, and construction experts. The team should include consultants with special competence in understanding and resolving indoor air quality issues. Some authors suggest that architects recommend to their clients that indoor air quality or indoor environmental consultants be retained on every building project.

The architect and the owner's representatives should develop a clear set of performance specifications as part of the direction given the mechanical engineer. In addition to the usual data on anticipated climate and acceptable indoor environmental conditions, outside air supply and ventilation efficiency should be specific elements of the directions given the mechanical engineer. Also, the means to be used to confirm the performance of the ventilation system in the completed building should be discussed and the agreed objectives pursued as part of the services of the mechanical engineer.

The architect's responsibility for the design consultants' work includes coordinating and integrating their various design inputs. Building construction and post-occupancy problems often arise from inadequate coordination of design consultants. Ideally, all of the critical members of the design team will assemble periodically to review progress and discuss concerns. The indoor air quality specialist should be part of the assembled group.

Site Evaluation. Architects and engineers are often called upon to evaluate potential building sites for their clients. Included in the criteria for site evaluation should be the potential impact of the site itself on indoor air quality, including climatic factors and local topography and buildings. Important considerations will be identification of on- and off-site sources of air pollutants and the various conditions that will require their control.

The sources of air pollutants might be adjacent or nearby stationary pollution sources, for example, exhausts from factories or from commercial buildings such as dry cleaning establishments or restaurants. The location of nearby roadways, parking lots, and garages and their motor vehicle traffic patterns might result in off-site pollution sources. Consideration should be given to variations in the potential sources over time including daily, weekly, and seasonal patterns.

The temporal and spatial variations in wind direction and velocity, traffic patterns, or emissions from industrial processes should be considered. The locations and forms of adjacent buildings might result in local wind patterns that cause re-entrainment of the planned building's own exhausts.

Previous land uses, such as agriculture or industry, might result in emissions from contaminated soil or groundwater as a potential indoor air pollutant source. Some examples of potentially significant sources might include wood preservation and treatment; solid waste handling, storage, and treatment; dry cleaning processes; leather, paint, or chemical manufacturing; refrigerated storage; gasoline stations; and agriculture. Even nearby building demolition can result in significant site contamination through release of building materials such as asbestos into air or into soil, which may remain on site or be back-filled onto it. If the prior history of the site is not known, it should be discovered before final site acquisition or design.

Valuable air quality and weather data are available from local air quality monitoring and regulatory agencies, National Oceanic and Atmospheric Administration monitoring stations, airports, harbors, and even certain resort and athletic establishments. Data on prior uses of sites may be available through historic building surveys or documentation, older fire insurance maps, municipal land use records, assessors' and recorders' files, and other state and local health, waste disposal, or hazardous materials control agencies.

A set of manuals for air quality considerations in residential planning was prepared for the United States Department of Housing and Urban Development in 1978. While written for the residential environment, the methods and procedures described there will be useful for any type of building. These manuals provide illustrative base maps, calculations sheets, and other aids to the preparation of a comprehensive assessment (Thullier 1978a,b,c).

Design Phase.

Building design activity is usually divided into three phases: schematic design, preliminary design, and design development. During schematic and preliminary design, the basic building concept is devised and placed on the site. During design development, the details of the design are worked out and specific materials, components or systems are selected.

Most of the elements designed during schematic and preliminary design are re-worked, refined, and detailed during design development and once again during the production of working drawings and specifications.

Schematic Design. During this phase of the work, the conceptual framework of the building is articulated. Major spatial and functional relationships, general sizes and locations of important building elements, architectural and engineering concepts, and relationship of the building to the site and its surroundings are all determined. Conceptual approaches to ventilation and thermal control (as well as many other critical building design decisions) are considered and tentatively resolved during the schematic design phase. The schematic design is developed to the point that a recognizable building form and general materials and systems are articulated in drawings, models, and written descriptions.

Preliminary Design. The building design includes siting, orientation, configuration, and interior layout. The basic characteristics of the building, its size, shape, exterior shell, systems, and materials are determined during the preliminary design work. Of particular importance to indoor air quality are the selection of major environmental control strategies including illumination, ventilation, and thermal control. This is the time to consider the implications of such choices beyond the conceptual level and to evaluate the trade-offs among significant alternative designs. This often involves preliminary calculations of loads and the capacities of systems designed to handle them. Also important to indoor air quality are the selection of major building materials and equipment other than for environmental control. The selection of these building components can have a large and lasting effect on indoor air quality and, therefore, should be done with adequate consideration of their IAQ impacts.

Site planning and site design are an integral part of the design process. If pre-design site assessment has not been completed, the design phase should begin by assessing ambient air quality and potential external sources of indoor air contaminants. The process described above under the "Site Evaluation" should be followed. By assembling and reviewing weather, air quality, soil, and traffic data available from local, state, and federal agencies, architects and engineers can develop reliable information to identify and evaluate the potential sources, characteristics, source strengths, and points of origin for air contaminants. This information can then be used during design to identify and assess various alternative design solutions to address potential sources of indoor air pollution.

Solutions might include locating the building on the site as far removed as possible from pollutant sources, or out of the normal wind patterns coming from pollutant sources. Air intake locations for both mechanical and natural ventilation systems can be eliminated or minimized where outdoor air pollution plumes would be expected. Vegetation or other screens can be utilized to form a barrier to particulate matter or to adsorb certain chemicals. Vegetation might be particularly effective in protecting a building from motor vehicle pollutant sources.

Building design solutions might include locating air intakes remote from pollution generation points or areas, creating architectural barriers to direct polluted airflow away from building air intakes, providing appropriate filtration for identified pollutants, or locating air-pollutant-sensitive elements away from exterior sources. Selection of window and door systems might include consideration of their designed protection against outside infiltration and the outdoor air pollutants that might pass through the openings. Designers can also consider the impact of the building fabric on identified pollutants, which might interact physically, chemically, or biologically with the building fabric or systems.

Design Development. During design development, the preliminary design is made more specific and detailed. Engineering calculations are made. Exact sizes of components of the building are fixed. Choices of finish materials and equipment are considered and alternatives are evaluated. Product research is done by use of catalogs, data sheets, product design manuals, and by contact with technical representatives. During this phase of the work, there should be continued consideration of indoor air quality implications of alternative design options.

Building Ventilation. Ventilation's role in controlling air quality in buildings is significant. The designed air exchange rate, the choice of constant or variable volume air supply, the use of pneumatic or electronic controls, the general location of intakes and exhausts for the building and each space within it exemplify important indoor air quality determinants. The best solution will vary from project to project. Certain considerations are fundamental to the selections that will result in acceptable indoor air quality (NAS 1981; Turiel et al. 1983; Turiel 1985).

Designers should consider the following important factors in designing building ventilation systems:

1. The quality and quantity of outside air supply under various climatic conditions and HVAC operational modes;
2. Supply air conditioning (filtration, humidification, thermal control);
3. Air distribution system type, materials, equipment, and controls;
4. Operation, maintenance, and monitoring of ventilation systems.

Architects should review the engineer's efforts to optimize indoor air quality, comfort, and the ventilation system's operational cost. They should consider the distribution of costs between construction and operation and between building management and tenants.

Thermal Control. Occupant comfort, air pollutant emissions into indoor air from building materials and furnishings, occupant perceptions of air quality, and pollutant removal rates or dilution rates are affected by air temperature. Thermal regulation systems can generate, exacerbate, or reduce indoor air pollutants. Where ventilation systems are used for thermal control, designers should consider temperature and air quality together.

Ventilation Efficiency. The decisions made at this stage will have significant impacts on ventilation efficiency, which can indicate the potential of the ventilation system to provide acceptable indoor air quality in the breathing zone. Design and operating conditions affect ventilation efficiency, which varies significantly among buildings, within buildings, and even in a single building. If ventilation efficiency measurements in both laboratory and field situations reported in recent years are representative of actual conditions, then far less than the designed ventilation rate, often between 50% and 75%, is typical (Persily 1986; Seppanen 1986).

Thus, actual ventilation rates in the breathing zone require that both the outside air supply volume at the diffusers and the ventilation efficiency be specified as design conditions. The combination will yield a performance specification for air exchange in the breathing zone. Alternately, a ventilation efficiency rate can be assumed and its inverse applied as a correction or safety factor to the desired supply air volume in the breathing zone to obtain the required supply air volume at the diffuser. Regardless of the approach chosen, building designers can adjust the design to provide the required air supply volume by joining ventilation efficiency to air exchange or outside air supply quantities.

Architects can improve ventilation efficiency by carefully locating and sizing air supply and return registers within the conditioned space. This might include architectural decisions to locate supply registers in the floor or walls rather than the dominant current practice of locating them in the ceiling. Or, air could be distributed under floor (more easily under raised floors) and then through easily connected and relocated risers to individual work stations. There, an occupant-controlled diffuser at desktop height can be adjusted for volume and direction of flow. This is just a single example of innovative design approaches that might emerge from efforts to improve ventilation efficiency. In fact, this concept has already been implemented in at least one high-rise office building (Doubilet and Fisher 1986).

During design, measurement of ventilation efficiency in a mockup or model of the designed space can assist in adjusting critical design variables to improve HVAC performance. This procedure may be used to determine appropriate heights for free-standing partitions or for determining the impact of elevating the bottoms of such partitions above the floor. It may result in different configurations of low and high partitions to improve air distribution and movement patterns. Testing in mockups can be used for determining optimal ceiling heights or diffuser heights above the floor. Tests can be used to improve airflows due to relationships of supply and return air registers and the volumes flowing through them. Performance specifications can be developed in the mockups to allow contractors and air balance companies to use more discretion in achieving them in the field. Measurement in the completed space can be useful in determining actual HVAC system performance.

Production of Contract Documents

Production of working drawings and construction specifications, as they are often called, presents architects with many opportunities to make detailed decisions to implement earlier design concepts. Specific designations of materials, equipment, and layouts are developed in the preparation of the contract documents. Products are considered and selected. Here architects can exert enormous influence on clients as well as on the providers of the products. Architects can require potential product suppliers to develop and provide better information on the chemical contents of their products and their performance (such as emission rates of critical substances). They can provide clients with clear analyses of the air quality implications or trade-offs in important materials or equipment selections. Specifications can include performance requirements, such as ventilation efficiency of HVAC systems or chemical emissions of major finishes and furnishings.

Interior Design. Interior design and use of space can have significant impacts on indoor air quality and comfort. The interior space layout and uses should be considered in terms of the pollution-generation and pollutant-sensitivity of occupant activities, pollution-exposed areas, and practical measures to mitigate contamination. Special activities that will generate pollution (e.g., printing, duplicating, mailing, food preparation) should be identified. Available alternatives to mitigate the impacts of occupant-generated pollutants should be described, analyzed, and recommended.

Building Materials Selection and Specification. Materials employed in the construction of the building can have significant impacts on indoor air quality. Many materials are known emitters of toxic or irritating chemicals. Failure to evaluate and carefully select materials can result in unnecessary, costly, and troublesome contamination of indoor air (Molhave 1982, 1986; Sheldon 1986; Stolwijk 1984).

Architects can evaluate candidate products and materials in terms of their projected chemical emissions rates and the chemicals' known effects on occupants. Important materials are those whose use is extensive, whose emissions are large, either short- or long-term, and whose volatile contents are known toxins or irritants. Some of these materials are carpet systems (carpet, pad, and adhesive); flooring systems (floor covering, subfloor or underlayment, and adhesives); ceiling tiles; wall covering systems; thermal insulation, fireproofing, caulking materials, and sealants exposed to indoor air; and ductwork and additional materials in contact with the supply or recirculation air stream. In addition, furnishings and equipment within the scope of architectural services should also be evaluated. (A detailed description of the process for evaluating materials may be found in a companion paper.)

Architects can develop supplemental instructions to issue to potential vendors with the bid documents. These instructions can require submittal of complete information on the components of the products being offered. The information thus obtained can be used for product and materials evaluation based on published information or lead to further inquiry with the component suppliers.

On the basis of the review described above, architects can evaluate bids and submittals and recommend selection, further evaluation, or testing. By review of product literature and published data, architects can determine whether candidate products produce an unacceptable level of air contaminants. Negotiation with suppliers can result in implementation of measures to limit the toxic or irritating chemical content or emissions of selected products by changes in design or manufacture.

To reduce source strengths in the completed building, performance specifications may be issued with respect to material contents, emissions rates, design details, packaging, shipping procedures, and installation. Modifications to furnishings and finish materials, where required, are incorporated in the construction documents issued to potential bidders.

Loading an enclosed structure with products that release large quantities of chemical pollutants into the air results in contamination of the building fabric. Many of the chemicals, particularly the semivolatile ones such as pesticides and polychlorinated biphenyls (PCBs), are adsorbed on the surfaces of building materials and furnishings; they can then be re-emitted into building air later, during occupancy. The length of time when a newly finished or furnished building contains elevated levels of construction-derived chemical contaminants is thus extended.

Most products receive limited exposure to the environment after manufacture. They are usually packaged and prepared for shipping or storage promptly. Therefore, the packaging, shipping, and installation process presents many opportunities to limit the contribution of interior materials to deteriorated indoor air quality in the completed structure. Architects can specify procedures to reduce the amount of unstable chemical contaminants entering the building or building air. These include packaging and shipping procedures, unpacking and loading into the building, installation practices, and building ventilation during delivery and installation in the building. Maximum exposure to air circulation and warming prior to entering the building will decrease negative indoor air impacts.

Modifications of shipping container designs and packing can allow for more air circulation without significantly increasing exposure to soiling. Storage facilities often lack adequate ventilation to permit much off-gassing. By increasing air movement in warehouse facilities, certain products may be allowed to emit a significantly greater portion of their unstable chemical content. Carpets and other products can be exposed to elevated temperatures, steam, or air circulation in production facilities prior to packaging in order to reduce emissions when unpacked in the completed building. Even trucks can be modified to increase the off-gassing by providing for more air movement and air exchange during transport.

Installation of Furnishings. Many newly manufactured building materials and furnishings emit a major portion of their lifetime chemical emissions during the first few hours, days, or weeks they are exposed to the environment. Air circulation at their surfaces is critical to the release of chemicals. Elevated temperature, humidity, and exposure to ultraviolet light can also accelerate off-gassing (Tichenor 1986; Tucker 1986). Therefore, the quantity of chemicals emitted into building air can be reduced by exposing materials and furnishings to environmental conditions prior to their loading into the building. This involves a number of logistical considerations, such as protection of carpets and furnishings from soiling after packaging and protective wrappings are removed.

Construction Process

General Considerations. The construction process offers many opportunities to observe and correct problems before the building is completed and occupied. The review from an environmental quality assurance perspective of change orders, shop drawings and other submittals, and of installations in the field can be cost-effective in avoiding construction and occupancy delays, call-backs, and problems in the occupied building.

Implementation of methods and procedures available during construction can limit the pollutant load in the completed structure. Phasing and scheduling of activities like installation of carpet and ceiling tile, temporary ventilation, and control of strong air pollutant source materials entering the enclosed structure can be used effectively to reduce airborne pollutant levels during construction. Excess levels during construction will extend the time after completion when levels will be elevated.

Properly completing construction close-out, commissioning the new building, and training of operating personnel will further reduce problems in the newly completed and occupied building. Attention to indoor environmental quality during this phase of the project is a frequently neglected and critical determinant of the building performance.

Change Orders, Shop Drawings. Changes made and details supplied by contractors or designers during construction can significantly impact indoor air quality. These changes are often

made in response to previously unanticipated problems or events during construction. The change order and shop drawing approval process often fails to ensure that the new detail meets the design intent and the established performance criteria.

Architects and their consultants can review, evaluate, and follow-up on change orders, field orders, and shop drawing approval requests for items determined significant to indoor environmental quality. These might include HVAC system components, insulations, sealants, finish materials, and furnishings, among others. The list of items requiring special attention with respect to IAQ should be identified by the architect and the HVAC consultant.

Temporary Ventilation. The provision of temporary ventilation during construction can control air levels of chemicals that can contaminate building materials. Large surface area materials, such as thermal, sound, and fire insulations, textured plaster, wood, carpets, or fabric, can become "sinks" for chemicals as their air levels increase. Subsequent re-emission can cause elevated contaminant air levels in the completed structure. This increases the risk of occupant complaints or health problems and may require special ventilation to control contaminant air levels, an added but avoidable cost.

The architect can review the construction schedule and phasing to determine the need for temporary ventilation. Temporary ventilation recommendations described here are not intended as a substitute for oversight or review of compliance with labor laws applicable to construction workers. The purpose is solely to reduce the pollutant burden in the completed structure by mitigation measures during construction. Specific details can be made part of the general conditions of the construction contract. Review of construction documents and consultation with the client can help the architect determine feasible means of providing temporary ventilation. Analysis of available alternatives and recommendations for temporary construction ventilation procedures and schedule can also be specified.

Progress Inspections. Inspections by owner's agents and architects tend to focus on compliance of construction with contract documents, scheduling issues, and determinations related to field orders. The intent or function of the building materials or equipment is often overlooked and the result is poor building performance. If the performance goals and criteria are kept in mind, the architect's site visits can be useful in identifying construction or design problems that will affect indoor air quality. Architects can identify critical components to be inspected during construction and develop a plan of construction site monitoring or quality control related to indoor air.

Air balance work determines air velocities or static pressure changes to compute airflow volumes at various HVAC locations. This is done under full flow conditions to adjust the flows of individual HVAC system components to design specifications. Air balancing does not reliably estimate the delivery of air or removal of pollutants in the breathing zone, nor does air balance work verify the performance of the system under heating or cooling load. Architects can require that determinations of the systems performance under load and ventilation in the breathing zone be part of the HVAC balance and final approval process. (See the discussion of ventilation efficiency above.)

Commissioning Phase.

While increased attention has focused on the commissioning process recently, time and economic constraints often limit the implementation of good practice. Many indoor air quality problems are probably due to false economies in the commissioning phase. It is during this period that the building owner can best determine whether the product (the completed building) represents what was contracted for with the prime design and prime construction contractors. Contract documents should specify both the procedures to be used to ascertain this conformity and the means for resolving conflicts.

Architects should review and analyze the effectiveness of training programs included in control system or HVAC equipment construction contracts. This includes an evaluation of materials, equipment, and procedures used in training. They should also evaluate the preparedness of operating personnel to perform routine and extraordinary tasks required of them in the new building.

Architects are responsible for inspection of construction, approval of payment to contractors, and for determining the "habitability" of completed structures. Too often, indoor air

quality problems occur or begin due to premature occupancy of completed structures. By requiring evidence that a building's ventilation system is fully functional and that air quality is acceptable prior to initial occupancy, architects can improve IAQ. This can be accomplished through "performance testing" during or immediately after the "commissioning" of the completed building.

Initial Occupancy.

Initial occupancy can be the most difficult period for maintaining acceptable indoor air quality. Problems arise from off-gassing from new materials, an occupant population that has been stressed by a recent, sometimes reluctant move, incomplete or inadequate air balancing, and malfunctions in newly commissioned air handling or control equipment.

The initial occupancy period can be very useful for identifying construction problems and initiating corrective actions before warranties expire. A responsive building management approach to complaints can create positive occupant attitudes toward the building and the building management. Attitude and perception play as significant a role as physical reality in determining occupant physiological and psychological responses.

Architects and engineers can assist building owners and operators during the initial occupancy period by recommending provisional ventilation system operating protocols that maximize outdoor air supply and hours of operation and minimize operating temperatures. They can also recommend procedures for quick and economical evaluation of indoor air quality including objective (instrumented) methods and subjective, systematic methods (inspections, rating systems, and questionnaires).

Air quality monitoring and subjective evaluation are used to guide the transition from special protocols to long-term, "normal" operation (see discussion in "The Evaluation of Building Materials and Furnishings for a New Office Building" elsewhere in this volume).

On-going Operations

HVAC Maintenance. Many indoor air quality problems have resulted from inadequate or inappropriate maintenance of HVAC systems. Biological aerosols implicated in cases of building-related illness result from inappropriate HVAC maintenance. Architects and their consultants should review the manufacturer's recommended HVAC maintenance program and suggest improvements as required.

Building Maintenance. Some indoor air pollutants come from building maintenance materials. Examples include floor waxes, furniture polishes, carpet shampoos, and washroom disinfectants. Maintenance practices and schedules can exacerbate or minimize the contamination of occupied spaces. A careful review of maintenance plans can screen potential indoor air quality problems and reduce or eliminate many of them. Volatile chemicals should be minimized, and their application should occur when buildings are vacant, where possible, with good ventilation and maximum time until normal occupancy recurs.

Pest Control. Insecticides, fungicides, and rodenticides, while useful in controlling pests, can cause serious indoor air quality problems through misapplication or inappropriate timing of application. Careful planning and monitoring can avoid unnecessary problems while maximizing the benefits of pest control applications. Architects can consider minimizing the need for on-going pesticide applications by selection of materials and construction details during design. Examples are materials not subject to attack by micro-organisms and design details that do not provide locations for pests to hide, colonize or move about.

Evaluation of completed buildings offers an excellent opportunity for architects and building owners and operators to learn from their prior work. Post-occupancy evaluation, as it is called, is rarely done. The building industry can learn how to improve indoor air quality by studying the impacts of different design approaches on subjectively and objectively measured IAQ in completed buildings. Longitudinal studies, including surveying attitudes and opinions of future or prospective building occupants prior to occupancy and then at various stages after occupancy, can provide extremely useful information on occupant perceptions. Relating subjective evaluations to indoor air monitoring or ventilation system evaluations can assist building designers and developers to achieve more satisfying and economic indoor environments.

CONCLUSION

Architects, engineers, interior designers and building owners, managers and operators can make substantial improvements in indoor air quality. Many procedures can be applied during a building project as modifications of normal practices. By approaching every phase of the building process with concern for indoor air quality, the design, construction and operation of the building can be modified to reflect the understanding now available from indoor air research. Researchers can enhance the efforts of architects and others to improve indoor air quality by focusing research on design issues and by communicating research results to the design and construction community.

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TABLE 1
Major phases of a building project

Project planning
Design
Construction documents
Construction
Commissioning
Initial occupancy
Ongoing operations

TABLE 2
Project Planning Phase

Programming
Budgeting and Economic Analysis
Project Scheduling
Selection of Design Team

TABLE 3
Design Phase

Schematic Design
Preliminary Design
Design Development

TABLE 4
Construction Documents Preparation Phase

Plans
Specifications

Materials Selection
Equipment Selection
Construction Procedures
Contract Provisions
Interior Design

TABLE 5
Construction Phase

Contract Administration
Change Orders
Shop Drawings
Observation of Work
Progress Reports
Approval of Payments

Temporary Ventilation
Protection of Permanent Finishes

TABLE 6
Commissioning Phase

Start-up Operations
Air Balance
HVAC Check-out
Air Quality Evaluation
Training Building Personnel

TABLE 7
Initial Occupancy Phase

Ventilation Protocols
Subjective Evaluation of IAQ
Occupant Orientation Process
Occupant Response System
Problem Handling Procedures
Enforcement of Warranties

TABLE 8
On-Going Operations Phase

HVAC Maintenance
Building Maintenance
Pest Control
Evaluation
Complaint Handling and Response
Occupant Control

Inspection
Monitoring

Mr. SCHEUER. Congressman Kennedy.

Mr. KENNEDY. Mr. Chairman, I have just a question for the witness, Mr. Clay. You indicated a few minutes ago in your testimony that you felt that EPA had already the existing authority to deal with this problem, and I just wonder if that is the case then why don't you believe that we have an effective plan in place now? I mean, obviously with 45,000 cases of Legionnaire's Disease in the country there's something — with the kind of radon problem that exists in the nation, and given the fact that the Chairman has tried to raise this issue for a number of years. I wonder whether or not this is strictly a problem in EPA or whether we've got OMB problems here as well.

Mr. CLAY. Well, my statement was that I thought we had sufficient authority to do it. The question then becomes how much resources are allocated to fulfilling those functions, and resources, as has been pointed out, are very tight to come about within the agency. It's a question of any given program in the agency I think could spend more money, it's a question of Mr. Thomas taking an original cut, of balancing the different priorities, and then later on OMB acting on behalf of the President balancing the different competing authorities.

So that's why I stand by what I said. I think we have the authority to do what's there, and it's a question of how much money we choose to spend there versus on other programs.

Mr. KENNEDY. Yes, sir. And I guess the only response to that from the Congress is that we have a responsibility to set some of those priorities as well, and the fact is that we're hearing directly, if you will stay and listen to the testimony, from lots of people around this country that are very, very concerned about this issue. There are people within EPA, as I understand it, that have indicated that indoor air pollution is a greater problem than outdoor air pollution in terms of the number of actual human beings that it affects each year.

So I don't question that somehow or other the EPA—and this is certainly not to be viewed and I hope you don't view it as me criticizing the EPA as an agency. What I do question is those individuals who are setting the priorities for EPA as an agency at this point. You don't have to comment.

Mr. CLAY. I'll accept that as criticism.

Mr. KENNEDY. Well, that's your judgment. What I'm trying to do, sir, obviously is to get the agency focused on what would appear to be a very significant health threat to the people of our country, and to make certain that the resources that the agency needs in order to fulfill that purpose, that they have.

Mr. CLAY. We appreciate your interest.

Mr. KENNEDY. Thank you very much.

Mr. SCHEUER. Ms. Schneider.

Ms. SCHNEIDER. Welcome, Mr. Clay. This bill is described by Senator Mitchell and some of the supporters as being a non-regulatory approach to indoor air; however, there have been representatives from various communities that have approached us and they're particularly concerned with Section 6 which uses the phrase "no health effects level" in the health advisories—concern that they

will end up being used as a standard and therefore having the effect of a regulation.

What is your interpretation, since you are the ones that would be responsible for setting any regulations or determining whether this is a standard. How do you translate what you are reading in this bill?

Mr. CLAY. Our reading is the literal reading, that it would not be a standard, it would be something that would provide information on the health effects.

One of the observations I have, though, with respect to radon is our four picocuries per liter effect which we believe is an action level, not a safe level. It's been picked up by many, for example, the real estate community, as being an absolute standard. So the fact that we judge it to be only informational level and something that is useful to have is picked up by others outside the agency and almost has the effect as if it were.

Ms. SCHNEIDER. So that's their problem in other words.

Mr. CLAY. Yes, ma'am.

Ms. SCHNEIDER. If that's the way they choose to interpret it. Well, what about some of the other things. Did you, from your perspective, find some things missing such as in terms of additional measures, like an acceptable risk or the standard of pollutants, the concentration of outdoor pollutants versus indoor pollutants, or some of the technological feasibility or something else? Were there other things that you felt should be included?

Mr. CLAY. Given that you are going to do that in Section 6 I think you would be better off with perhaps more of the technical feasibility and some of the economics considerations that have to go into things. Yes.

Ms. SCHNEIDER. When you refer to economics, could you elaborate a little bit on that?

Mr. CLAY. Yes. One of the things I think ought to be considered by people is how much the solution costs; what is the mitigation cost of doing it. One of the things we can do in radon, as we've all pointed out, is we can measure it fairly cheaply and the mitigation is very cheap, and I think that's something people have to consider.

Ms. SCHNEIDER. Right. There's another, Section 7 requires the agency to draw up a national indoor air quality response plan to reduce the exposure to the fullest extent practicable. And it says, "to levels at which there is no known or anticipated human health effect". EPA is also required to draw up a plan using authorities from the Toxic Substances Control Act and the Federal Insecticide, Fungicide, FIFRA, et cetera.

So since the goals of TSCA and FIFRA are not reductions of exposures to a no health effects level, how will the differences in those two bills, those two authorities, be reconciled between this bill and those two acts? Is that something we have to be concerned with, or more importantly, probably you would have to be concerned with it.

Mr. CLAY. I'm sure we would have to be concerned. The TSCA and FIFRA, there you have an unreasonable risk finding to do something, generally ban something, so there you're going in a true regulatory approach, generally banning something or perhaps, in the case of FIFRA, labeling for proper use.

The other approach that we have in the bill, though, is a non-regulatory approach where we're going down and providing information to consumers or the American people about the various specs of different levels without picking an actual level. So I don't see a real conflict. If there's a real problem the agency has always said we'll use the authority of TSCA, FIFRA or the drinking water act or whatever to take a regulatory approach. The bill provides information and people make their own decision.

Ms. SCHNEIDER. Okay. Another thing I wanted to mention. You have basically put out a health advisory with the Public Health Service stating that radon is a national health problem, and you have advised that most people check their homes which I certainly have been encouraging all Rhode Islanders to do that. But currently, you make information on testing available to the public, and I'm wondering how does the agency plan to promote this testing on a more widespread basis? We've had great help from the media but it's just been little spurts, and I'm concerned that the whole attention to this could die down in terms of public awareness. Do you have some kind of public awareness campaign in mind?

Mr. CLAY. Well, we're working with the National Advertising Council and some PSA's to do that. We thought the involvement of the Public Health Service in our last announcement was something that would help in terms of bringing some credibility. There is a health problem here. The media does play a very important part in this, and we'll continue to work with them in doing it. So we're very active in trying to do that, particularly working then through our state and local contacts to do this. But it's a difficult problem to get people to pay attention and test.

Ms. SCHNEIDER. I think one of the things that I've encountered in terms of educating the public is that it's almost like an individual finding a lump on their neck or something. They think, Oh my goodness, it could be cancer; I don't want to check it out. And so people will live with this problem for a while because of the fear of knowing that there may be a problem.

Now, this is the kind of feedback I have gotten from many, that they'd just as soon not know, because they're not aware that there are solutions. So I think that as we communicate the problem, it's almost even more important to say that there are inexpensive solutions available.

Mr. CLAY. That's one of the things that we certainly try to communicate, and we've found the same thing. People would say, I'd rather not test, I'd rather not know, because if I know, when I sell my home it's a disclosable fact; therefore the value of my home will suffer even if I've already mitigated it. So we certainly try to make the information available and we certainly try to promote the whole thing, but we'll never get 100 percent cooperation because there is some segment that does not want to know.

Ms. SCHNEIDER. One last question. Insofar as the number of homes that need to be tested and the number of homes that have already been tested, do you have a breakdown of those figures?

Mr. CLAY. Well, there are about 80 million homes in the United States and as you know, what we recommend is that all of the individual homes be tested and the first and second floors of apartments. There has been around one percent of those, about 800,000

that have been tested. All will never be tested for the various reasons we just talked about: some people don't want them tested. So the breakdown is there are about one percent of the homes that we believe should be tested have been tested.

Ms. SCHNEIDER. Have you indicated when you figure the whole national survey on radon would be complete?

Mr. CLAY. We'll be initiating the survey with the funds provided by the Congress next fiscal year and will run for several years; two to three years.

Ms. SCHNEIDER. Is there not one report, though, that is due very soon, in the next couple of months?

Mr. CLAY. We have the report under Title IV of SARA on what's going on, the activities that are going on and what we're doing and recommendations for further action. The National Survey was also required, but it's a later date. I think we're actually late on that, too, but the actual answer is we'll have it in two to three years.

Mr. SCHEUER. Excuse me. On that point you mentioned to us that that report which is owing by the end of October won't be forthcoming at that time, but it will be forthcoming within the next month or two. I'd like you to give us an exact date that we can expect to have that. We're unhappy that you can't meet these target dates that are in the law. It's a legislative mandate that has real meaning, and there's been too much of a casual attitude in the past with EPA, I'm not blaming you personally, Mr. Clay, but frequently, the EPA has missed these dates by months and months and months and months and months, and we take objection to that.

So what I'd like to do is pin you down to a date that you think you can get it in, and then by golly, make sure that you get it in by then.

Mr. CLAY. All right. We'll give you December 31st and I'll try very hard to beat it, to get in ahead of that. Actually what happened in this case is rather interesting. We took a lot of people off that to work on the EPA problem in our building, is one of the reasons. But nevertheless, I can appreciate the congressional concern and—

Mr. SCHEUER. It's legitimate, don't you think?

Mr. CLAY. Very much so, yes, sir.

[The material referred to follows:]



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC 15 1988

OFFICE OF
AIR AND RADIATION

Honorable James H. Scheuer
Chairman, Subcommittee on Natural Resources,
Agriculture Research, and the Environment
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Scheuer:

I am writing to provide you with an update on our progress in preparing the Report to Congress on indoor air quality required under Section 403 of the Superfund Amendments and Reauthorization Act of 1986 (SARA). As you know, this report was to be submitted within two years after enactment, describing the activities carried out under Title IV of SARA and making such recommendations, as appropriate.

The report, as currently drafted, is entitled The Federal Response to Indoor Air Pollution and consists of three primary volumes, plus an Executive Summary which contains several recommendations. Volume I of the report, Federal Programs Addressing Indoor Air Quality, reports on the indoor air exposure activities underway at EPA and describes the indoor air activities of the many Federal agencies with which we have been working closely in the development of the report.

Volume II, Assessment and Control of Indoor Air Pollution, is a more substantive report on the indoor air quality issue, covering what is known today across a broad front, including pollutants, sources, modeling and monitoring methods, concentrations, exposures, health effects, existing standards, codes and legislation, economic impacts and policy issues. This volume is intended to provide the reader with a good basic understanding of the current level of knowledge and uncertainties concerning indoor air quality issues.

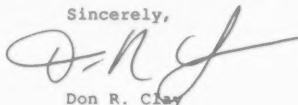
Volume III, Indoor Air Research Needs Statement, reflects the output of an interagency workgroup led by the Office of Research and Development. This volume highlights the major gaps and research needs in the indoor air field, suggests a two tier priority ranking scheme, and estimates resource implications.

The draft report is now undergoing a thorough review both within EPA and among the other Federal agencies, many of which contributed to the preparation of Volumes I and III. However, while we have made substantial progress and are making every effort to expedite the review process, it does not appear that we will make the December 31, 1988, date we had hoped to be able to achieve at the time of your September 28, 1988, indoor air hearing.

The delay is due in part to the fact that our Indoor Air Division has been devoting substantial portions of its time to implementing the other provisions of SARA Title IV as well as working with our own building management to address the indoor air quality issues here at EPA headquarters. In addition, the substantive nature of the report, the need to coordinate extensively with a large number of EPA programs and other Federal agencies, and the formal clearance process are, as you know, time consuming endeavors. Finally, we anticipate that the new Administration might wish to contribute its thoughts to the report as the transition occurs.

I can assure you that I will do everything in my power to expedite the process. I would estimate that we will be able to put the report into an expedited internal Red Border clearance process in early January and submit the report to the Office of Management and Budget (OMB) by the end of January. We would then transmit the report to Congress as soon thereafter as possible. If you have any questions or would like to discuss the report, please do not hesitate to contact me.

Sincerely,

A handwritten signature in dark ink, appearing to read "Don R. Clay", with a stylized, flowing script.

Don R. Clay

Mr. SCHEUER. All right, then we'll hold you to that December 31st. Frankly, we're all hard-working people but I don't think any of us are hard-working enough to be around here on December 31st. Perhaps Congressman Kennedy will be because he's deeply concerned.

[Laughter.]

And of course Claudine Schneider I know will be here waiting for that report.

If you could get it in at a more salubrious date, for example, December 1st or December 15th then we'd be here to receive it, and we'd have a chance to study it and hope that shortly after the first of the year we could get you down here for a little friendly oversight hearing.

Mr. CLAY. Be pleased to come, sir, and we'll leave December 31st as the official date and we'll certainly try very hard to get it here in a shorter time.

Mr. SCHEUER. Thank you very much. I yield back.

Ms. SCHNEIDER. Thank you. Two more technical questions so that we really have a complete hold on this challenge that we're facing.

There have been some questions raised about the performance of the short term versus the long-term testing methodologies; whether we go with the charcoal canisters or the alpha tracking. What is the research that you are coming up with on this?

Mr. CLAY. What we recommend is that the canister, the short-term test, two to three days, be used as a screening level, and that's something relatively cheap, maybe on the order of \$10 to \$20 per test. If in fact you find a level that you think is significantly higher than four picocuries or whatever level you find, before you take any mitigation action we recommend that you go ahead and then do the more accurate alpha track which costs you on the order of about \$20 to \$50. The alpha is clearly a more accurate device, allows you to go over a longer period of time. And radon is not constant, it goes up and down and gives you essentially an average over a several-month period. So we recommend the use of both, but because of the expense we screen with the charcoal canister, and we use the alpha track for the more accurate. Alpha track, for example, is what we'll be using in the National Survey.

Ms. SCHNEIDER. Well, that's very impressive, the depth of investigation that you are using.

Are we going to be able to identify—I mean, given the fact that we want to be very effective in a very short time period with a very limited amount of money—has EPA as yet identified the hot spots around the nation so that we could zone in some of them, do some crises management and at the same time do a little long-range planning?

Mr. CLAY. Well, the National Survey will give us a national picture projection but it won't be useful in particular for the hot spots. The hot spots are the state surveys that we're doing. We did ten the first year, seven we just completed. Those are useful in identifying hot spots, and we're working with states to solve those, so we'll continue on. We have another set we're doing next year, and we'll continue on until the states don't want to participate any longer.

Ms. SCHNEIDER. Okay. Great, thank you. Thanks very much, Mr. Chairman.

Mr. SCHEUER. Congressman Kennedy? Tim Valentine of North Carolina.

Mr. VALENTINE. Mr. Chairman, I appreciate the opportunity to question the witness but since I have not heard his testimony, I got here late, I'm sure I'd ask questions that have already been answered.

I would simply suggest that in making plans for the receipt of the report, perhaps the gentleman could meet the subcommittee someplace, maybe in Bermuda, on December 31st.

Mr. SCHEUER. And we'd receive the report then and work the evening of December 31st, diligently.

Mr. CLAY. I'd be pleased to hand carry it personally, Mr. Chairman.

Mr. VALENTINE. Mr. Chairman, I would like the record to show that since I did not expect that, I speak in jest.

[Laughter.]

Mr. SCHEUER. The record will show the jest and the laughter.

All right, Mr. Clay, thank you very much for your very forthright and very informed testimony. We appreciate your candor and we look forward to working with you next year. We look forward to the timely receipt of that report which we've discussed. Thank you very much.

Now we'll go to the next panel, Ms. Sandra Eskin, Dennis Parker and Rosanne Bacon. Ms. Sandra Eskin is Legislative Representative of the CFA, the Consumer Federation of America, which has done so much for the consumers of our country for so many years. Congressmen like myself and Madame Schneider and Joe Kennedy, we're all so dependent on the model, this high quality scientific research and advisories of all kinds that CFA gives us that it's perfectly clear we wouldn't be anywhere nearly where we are in the length and breadth of consumer protection if it weren't for the marvelous work, the highly professional work, competent work that the CFA turns out and makes available to us.

Next is Denis Parker, Executive Director of the State Employees Association of New Hampshire, Local 1984, Service Employees International of the AFL-CIO, and I would call upon Joe Kennedy to introduce the third witness.

Mr. KENNEDY. The third witness is really the third and fourth witness, Mr. Chairman. I take great pleasure in welcoming Rosanne Bacon who is the newly elected President of the Massachusetts Teachers Association. She comes highly recommended first of all because she happens to have been born in the 8th Congressional District in Massachusetts, but also as you are well aware, Mr. Chairman, the NEA has been a tremendous force in a whole range of issues outside of just education, and it seems that Ms. Bacon has continued in that leadership, and I look forward to working with her on a range of different issues in the future. And I very much appreciate your coming down today, Rosanne.

In addition,—

Mr. SCHEUER. Well, I'm delighted to have you here, and I express the pleasure of the member from the 8th District in Massachusetts

and the pleasure of the member from 8th District of New York in your appearance here.

Mr. KENNEDY. Thank you, Mr. Chairman. In addition, a wonderful teacher from the City of Cambridge, Kathleen Clinton, who I think is really kind of a hero in the whole fight for indoor air pollution standards. Kathleen has continued to work at the particular school she works at in Cambridge despite being seriously ill for the past ten years as a direct result of the pollutions that she is allergic to in that building. And I think it's a dedication that we don't see often enough in government and she is to be highly commended and congratulated for her work and her determination. So really a strong welcome to both of you. Thank you for coming down.

Ms. BACON. Thank you very much, Congressman.

Mr. SCHEUER. Very good. We'll start at the top of the list, Ms. Sandra Eskin, CFA Representative. Why don't you take five or six minutes and give us your message informally, and may I say for all of the witnesses that your prepared testimony will be printed in full at the time that you testify, so just consider that we're all in a living room together and we're chatting informally and we're listening to you share your views with us. Ms. Eskin.

STATEMENT OF SANDRA ESKIN, LEGISLATIVE REPRESENTATIVE, CONSUMER FEDERATION OF AMERICA

Ms. ESKIN. Thank you, Mr. Chairman, and members of the subcommittee for convening this hearing and inviting us to testify. I also want to commend you on your leadership in focusing national attention on indoor air quality. Both you and Congresswoman Schneider were instrumental in passing SARA, the 1986 Superfund Amendment, which included the first legislative recognition of the enormity of the problem posed by indoor air pollution.

The Consumer Federation of America represents more than 240 local, state and national consumer advocacy organizations. Indoor air quality has been a key health and safety priority for CFA for many years. We view it as the Number One hidden health threat to our nation.

What I want to focus on today is the need for additional legislation to improve indoor air quality. As evidenced by its recent radon survey, EPA is waking up to the seriousness of the health impact of radon, only one of hundreds of indoor air pollutants. The agency has issued a health advisory urging all homeowners to test their residences for radon. However, the federal government has to do more than serve as the national alarm clock signaling the public that it's time for them to act. In the area of indoor air quality in general it's time for the administration to wake up to the fact that more resources must be dedicated to assessing the full scope of indoor air pollution and to developing methods to alleviate it.

Until SARA was enacted, EPA was even questioning its own authority to conduct research on indoor air quality. With SARA, EPA has begun to focus on indoor air pollution. However, more than just a few million dollars a year is needed to mount an effective attack on this problem. Reports, fact sheets and directories on indoor air pollution are necessary, but they are not sufficient. It is time to go beyond SARA. EPA must be given additional resources

for extensive research on indoor air quality, and they must be given clear direction to develop a comprehensive program for dealing with indoor air pollution.

CFA supports H.R. 5373, recently introduced by Congressman Kennedy, as the necessary next step in the fight to improve indoor air quality. We urge the administration to support this measure. The EPA criticized the initial indoor air proposal introduced last year in the Senate as too expensive. H.R. 5373 authorizes approximately \$50 million each year for a five-year period; a 17 percent decrease in the original authorization amount. Too expensive? Not when one considers the annual cost of indoor air pollution in terms of lives lost, medical expenses and lost productivity. Any significant decrease in funding below the proposed level would not allow EPA and other related agencies to sustain an effective assault on the indoor air problem.

Testifying on the original Senate indoor air proposal, the EPA also characterized it as too much too soon. CFA believes that without adopting legislation like H.R. 5373, what we will face in trying to remedy indoor air pollution is too little too late.

I'd like to highlight a few of the provisions in the proposed legislation that are of particular interest to CFA. One critical element of the legislation is the indoor air contaminant health advisories. In response to critics of this approach, we believe that consumers have a right to know the risks they face from exposure to indoor air pollutants, and that they are capable of understanding these risks. This information can be communicated to consumers without unnecessarily alarming them. Moreover, if these are to be true advisories, then they should include not only risk information but also mitigation information to make them useful and effective for the public.

Another vital aspect of H.R. 5373 is the establishment of a national indoor air quality information clearinghouse and of a toll free hotline to provide general, non-technical information to the public about indoor air quality and contamination problems.

One issue not specifically addressed by this legislation but related to the need for consumer education in this area is our concern about indoor air fraud. You may have heard some of the same horror stories we have about radon testers who claim they can take radon measurements with an empty mayonnaise jar or a geiger counter. This problem is the consumer's worst nightmare; a serious health risk coupled with the opportunity for fraud and deception. Widespread consumer education would help protect against such fraud, but more should be done.

Congress should direct EPA to study this problem and consider possible protections such as a certification program for indoor air diagnostic and mitigation firms, similar to the program established by EPA for radon; and/or an EPA-sponsored training program for indoor air testing firms.

CFA views H.R. 5373 as the necessary next step in improving the indoor air quality of our nation's homes, schools and offices. This legislation would provide the framework whereby Congress, the administration, state and local governments, the private sector, consumer groups and individual citizens could work together to ensure that we can all breathe a little healthier.

Thank you.

[The prepared statement of Ms. Eskin follows:]



Consumer Federation of America

S T A T E M E N T

before the

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH
AND ENVIRONMENT

of the

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

on

EPA'S PROGRESS IN IMPLEMENTING
INDOOR AIR POLICIES

by

SANDRA B. ESKIN

Legislative Representative

Consumer Federation of America

September 28, 1988

Mr. Chairman and Members of the Subcommittee, I am Sandra Eskin, Legislative Representative for the Consumer Federation of America. CFA represents more than 240 local, state, and national consumer advocacy organizations.

I want to thank you, Mr. Chairman, and members of this subcommittee for convening this hearing and inviting us to testify. I also want to thank you for your leadership in focusing national attention on indoor air quality. Both you and Congresswoman Schneider were instrumental in passing the 1986 Superfund Amendments and Reauthorization Act (SARA), which included the first legislative recognition of the enormity of the problem posed by indoor air pollution.

Indoor air quality has been a key health and safety priority for CFA for many years. We view indoor air pollution as the number one hidden health threat to our nation. People in this country are estimated to spend as much as 90% of their time inside, where exposure to toxic substances can be many times greater than what they experience outside. As many as 6500 cancer cases annually are attributed to indoor air pollutants not including radon. This country has long recognized the need to improve the quality of outdoor air and only now, due in large part to efforts like Title IV of SARA, are people beginning to

direct their attention indoors.

As evidenced by its recent radon survey, EPA is finally waking up to the seriousness of the health impact of radon exposure. The agency has issued a health advisory urging all homeowners to test their residences for radon. However, the federal government has to do more than serve as the national alarm clock signalling the public that its time for them to act. In the area of indoor air quality in general, its time for the Administration to wake up to the fact that more resources must be dedicated to assessing the full scope of indoor air pollution and to developing methods to alleviate it.

Until SARA was enacted, EPA was even questioning its own authority to conduct research on indoor air quality. In a report published last year, EPA acknowledged the seriousness of the problems posed by indoor air pollution and that sufficient resources are not being devoted to it.

More than a few million dollars a year are needed to mount an effective attack on indoor air pollution. Reports, fact sheets, and directories on indoor air pollution are necessary, but not sufficient. It is time to go beyond SARA. EPA, the expert agency, must be given additional resources for extensive research on indoor air and clear direction to develop a comprehensive program for dealing with this problem.

CFA supports H.R.5373, recently introduced by Congressman Kennedy, as the necessary next step in taking the problem of indoor air pollution seriously. This legislation is a

streamlined version of the original indoor air legislation introduced last year, reflecting revisions worked out in conjunction with Senator Mitchell's bill, S. 1629. This legislation is a compromise from our perspective. It does not establish enforceable standards nor does it afford new regulatory authority. Rather, it clarifies EPA's role as the lead agency in the fight to improve indoor air quality. H.R. 5373 would substantially expand current research efforts at EPA and significantly advance the dissemination of vital information about indoor air pollution.

We urge the Administration to support H.R. 5373. The EPA criticized the initial indoor air proposal as "too expensive." H.R. 5373 authorizes approximately \$50 million each year for a five years period, a 17% decrease in the original authorization. Too expensive? Not when one considers the annual costs of indoor air pollution, in terms lives lost, medical expenses, and lost productivity. Any significant decrease in funding below the proposed level could not support an effective assault on the indoor air problem.

Testifying on the original Senate indoor air proposal, the EPA claimed that it was "too much too soon". CFA believes that, without adopting legislation like H.R. 5373, what we will face in trying to remedy indoor air pollution is "too little too late".

I would like to highlight a number of provisions in the proposed legislation of particular interest to CFA. One critical element of H.R. 5373 are the "indoor air contaminant

health advisories," a compromise approach in lieu of enforceable standards. These advisories provide guidelines and important information to state and local officials in developing indoor air strategies. At the same time, they direct EPA to set necessary priorities to develop action on known contaminants.

In response to critics of the "health advisory approach", we believe that consumers have a right to know the risks from exposure to indoor air pollutants and are capable of understanding these risks. This information can be communicated without unnecessarily alarming the public.

To make these health advisories effective, however, two elements are essential. First, if these are to be health advisories, EPA should focus on health-based research and work in conjunction with the Department of Health and Human Services to develop the necessary data on the health effects to humans caused by exposure to indoor air pollutants. Second, if these are to be true advisories, then they should include not only risk data, but also mitigation information to make them useful and effective for the public.

Another vital aspect of H.R. 5373 is its establishment of a national indoor air quality information clearinghouse, which would provide objective and consistent information to consumers, local state and national agencies, health professionals, architects and builders, and industry. The inclusion of a toll free "hotline" to provide general information to the public about indoor air quality and contamination problems will facilitate

dissemination of non-technical information to consumers.

Related to the need for consumer education regarding indoor air pollution is our concern about "indoor air fraud," an issue not specifically addressed by H.R. 5373. You may have heard some of the same horror stories we have, about radon testers who claim they can take radon measurements with an empty mayonnaise jar or a geiger counter.

This problem is the consumer's worst nightmare: a serious health risk, coupled with the opportunity for fraud and deception. Widespread consumer education would help protect against such fraud in the diagnosis and mitigation of indoor air pollution problems. However, more could be done. Congress should direct EPA to study this problem in cooperation with state and local agencies and, where appropriate, provide states with technical assistance in addressing deceptive practices. One possible approach to this problem is a certification program for indoor air diagnostic and mitigation firms, similar to the voluntary radon measurement proficiency program established by the EPA. Another approach could involve an EPA-sponsored training program for indoor air testing firms.

The designation of EPA as the lead agency in dealing with indoor air pollution should in no way limit the responsibilities of other affected federal agencies, which must all work together to coordinate an integrated federal approach to improving indoor air quality. These agencies include the Consumer Product Safety Commission, which plays a critical role in controlling home

exposure to indoor pollutants emitted by consumer products; the Occupational Safety and Health Administration (workplace exposure), the Department of Energy (energy conservation standards), the Department of Health and Human Services ("sick building" assessment through the National Institute of Occupational Safety and Health), and the Department of Housing and Urban Development (indoor air pollution in federally subsidized housing).

CFA believes that any long-term strategy for mitigating indoor air pollution should ultimately involve building design standards, minimum ventilation rates, regulation of toxics, and development of model building code provisions.

We view H.R. 5373 as the necessary next step in improving the indoor air quality of our nation's homes, schools, and offices. This legislation would provide the framework whereby Congress, the Administration, state and local governments, the private sector, consumer groups, and individual citizens could work together to ensure that we can all breathe a little healthier.

Mr. SCHEUER. Thank you very much, Ms. Eskin. I'm going to ask unanimous consent from members of the committee that members can address further questions to all of the witnesses from all of the panels starting from the beginning today, and we'll keep the record open for 10 days or 12 days to provide time for the questions to be promulgated and for the witnesses to answer them.

We'll now recognize Denis Parker, Executive Director of the State Employees Association of New Hampshire. If you would take five or six minutes and just chat with us, hopefully not reading—just chat with us and give us your views. Your prepared testimony, as I said before, will be printed in full at this point in the record.

STATEMENT OF DENIS PARKER, EXECUTIVE DIRECTOR, STATE EMPLOYEES ASSOCIATION OF NEW HAMPSHIRE LOCAL 1984, SERVICE EMPLOYEES INTERNATIONAL UNION, AFL-CIO

Mr. PARKER. Thank you, Mr. Chairman. I'll try to do my best. I did come here with just a highlight of my remarks and my testimony that I was to offer you.

Good morning. My local union is one of the largest in New Hampshire; we represent over 6000 public employees. Nationally, the Service Employees International Union represents over 850,000 public workers and private sector workers, the majority of whom work in office buildings. Together with the Maine State Employees Association we have formed the New England Indoor Air Pollution Coalition. We banded together because indoor air was making our members sick and traditional methods of confronting this problem at the workplace had proved inadequate.

It is on behalf of the workers represented by our organizations that I would like to thank the Chairman and members of the subcommittee for allowing us this opportunity to testify today. The legislation, H.R. 5373 before you provides a critical first step towards protecting workers and the general public by initiating the necessary research and education to identify and control indoor air pollution problems. We urge a quick passage of this bill.

Our Indoor Air Pollution Coalition came together in 1986 to share common experience and our knowledge base. We quickly determined that several factors were responsible for the failure of employers to successfully address this critical workplace hazard.

First, there is little or no knowledge about the problem among health professionals and decision makers. Second, there are no standards against which to measure poor air quality conditions. Third, there is an understandable but unacceptable desire on the part of public officials to turn a blind eye to these problems in the hope that by doing so the challenge they impose can be ignored.

The greatest victory of the Coalition to date has been the passage of indoor air pollution legislation, the first of its kind we're proud to say in the country, in New Hampshire, followed quickly by the state of Maine. Mr. Chairman and members of the committee, we believe this legislation introduced by Congressman Joe Kennedy addresses these concerns in a meaningful and constructive fashion, and it does so in a way that does not over-commit the federal government or ignore the role of other public decision makers. And that's why we are here today to support this federal legislation and

comment on some of the sections of this legislation that we consider of great importance.

First, we congratulate the drafters of the legislation for acknowledging in the Findings Section that indoor air pollution not only poses serious threats to public health but also reduces productivity at the workplace. Our surveys of state employees in Maine and New Hampshire demonstrate clearly that employees who work in sick buildings admit to reduced productivity. Some might argue that lost productivity is far less a harm or serious threat to the public health, but we have observed that it is often a better stimulus to change.

Second, the Findings Section makes specific reference to bacteria and fungi which often spawn inside improperly maintained air ventilation systems and contribute to indoor air problems. Third, while research is vitally important, it goes hand in hand with education. Where the facts regarding the causes and control of indoor air pollution are already known, education should be a priority.

Fourth, we applaud the inclusion of buildings leased by the federal government under the definition of Federal Buildings.

Fifth, under the Research Section, we support studies that will attempt to quantify the cost to employers from indoor air pollution. Examples of employer cost include lost productivity, sick time use, increased use of employer-paid health insurance and worker compensation claims.

Six, we believe that demonstration projects should more heavily emphasize the need to develop successful means to educate the public about these problems. Model education programs that provide examples of balance and cooperation will do much to help other decision makers realize that these are human problems and are manageable.

Seventh, again under the Research Section we would ask that you define non-profit institutions and organizations to specifically include, along with health and education organizations, employee advocate organizations such as ours.

Eighth, mentioned in the national response plans section, we support the critical need to provide concise yet comprehensive educational materials for all affected parties through the development of guidance documents.

Ninth, also under the national response section, it is important that Congress support the need for building occupants and other affected parties to be able to request building surveys by EPA or a designated authority when indoor air pollution problems are suspected.

Tenth, we believe that the toll free hotline and the clearinghouse section will prove to be a most useful resources to the public as we struggle to deal with these problems.

Finally, we believe the sponsors of this bill ought to be congratulated on developing legislation which recognizes the responsibility of federal leadership without ignoring the limitations of such involvement. Limitations that spring not only from fiscal constraints but also from the traditional limited role of federal government in matters concerning real estate property and buildings.

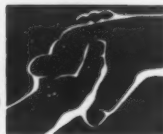
In summary, we believe this is a well-crafted bill which deserves the support of the subcommittee and the United States Congress, and we would urge your consideration of this legislation. Thank you, sir.

[The prepared statement of Mr. Parker follows:]

**SERVICE
EMPLOYEES**

INTERNATIONAL UNION, AFL-CIO, CLC

1313 L STREET N.W. • WASHINGTON, D.C. 20005 • (202) 898-3200

JOHN J. SWEENEY
INTERNATIONAL PRESIDENTRICHARD W. CORDTZ
INTERNATIONAL SECRETARY-TREASURERDRAFT

TESTIMONY OF

SERVICE EMPLOYEES INTERNATIONAL UNION, AFL-CIO, CLC

BEFORE

THE SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURAL RESEARCH, AND ENVIRONMENT
OF THE SCIENCE, SPACE AND TECHNOLOGY COMMITTEE
US HOUSE OF REPRESENTATIVES

ON

HR5373

THE INDOOR AIR QUALITY ACT OF 1988

September 28, 1988

SUBMITTED BY:

DENIS PARKER, EXECUTIVE DIRECTOR
THE STATE EMPLOYEES ASSOCIATION OF NEW HAMPSHIRE
LOCAL 1984 OF THE SERVICE EMPLOYEES INTERNATIONAL UNION
AFL-CIO, CLC

DRAFT 1

GOOD MORNING, MY NAME IS DENIS PARKER, AND I AM THE EXECUTIVE DIRECTOR OF THE STATE EMPLOYEES ASSOCIATION OF NEW HAMPSHIRE, LOCAL 1984 OF THE SERVICE EMPLOYEES INTERNATIONAL UNION, AFFILIATED WITH THE AFL-CIO, AND THE CANADIAN LABOUR CONGRESS.

MY LOCAL UNION IS THE LARGEST LABOR ORGANIZATION IN NEW HAMPSHIRE, REPRESENTING OVER 6,000 STATE EMPLOYEES. NATIONALLY, SEIU REPRESENTS OVER 850,000 PUBLIC AND PRIVATE SECTOR WORKERS, THE MAJORITY OF WHOM WORK IN OFFICE BUILDINGS. TOGETHER WITH THE MAINE STATE EMPLOYEES ASSOCIATION WE HAVE FORMED THE NEW ENGLAND INDOOR AIR POLLUTION COALITION. WE BANNED TOGETHER BECAUSE INDOOR AIR WAS MAKING OUR MEMBERS SICK, AND TRADITIONAL METHODS OF CONFRONTING THIS PROBLEM AT THE WORKPLACE HAD PROVED TO BE INADEQUATE.

IT IS ON BEHALF OF THE WORKERS REPRESENTED BY OUR ORGANIZATIONS, THAT I WOULD LIKE TO THANK THE CHAIRMAN, AND MEMBERS OF THIS SUBCOMMITTEE FOR ALLOWING ME THIS OPPORTUNITY TO TESTIFY TODAY. THE LEGISLATION, HR5373, BEFORE US TODAY PROVIDES A CRITICAL FIRST STEP TOWARDS PROTECTING WORKERS AND THE GENERAL PUBLIC BY INITIATING THE NECESSARY RESEARCH AND EDUCATION TO IDENTIFY AND CONTROL INDOOR AIR POLLUTION PROBLEMS. WE URGE QUICK PASSAGE OF THIS BILL.

OUR INDOOR AIR POLLUTION COALITION CAME TOGETHER IN 1986 TO SHARE COMMON EXPERIENCES AND OUR KNOWLEDGE BASE. WE QUICKLY DETERMINED THAT SEVERAL FACTORS WERE RESPONSIBLE FOR THE FAILURE OF EMPLOYERS TO SUCCESSFULLY ADDRESS THIS CRITICAL WORKPLACE HEALTH HAZARD.

FIRST, THERE IS LITTLE OR NO KNOWLEDGE ABOUT THE PROBLEM AMONG HEALTH PROFESSIONALS, AND DECISION MAKERS. SECOND, THERE ARE NO STANDARDS AGAINST WHICH TO MEASURE POOR AIR QUALITY CONDITIONS. THIRD, THERE IS AN UNDERSTANDABLE, BUT UNACCEPTABLE, DESIRE ON THE PART OF PUBLIC OFFICIALS TO TURN A BLIND EYE TO THESE PROBLEMS. IN HOPE THAT BY DOING SO THE CHALLENGES THEY POSE CAN BE IGNORED.

MR. CHAIRMAN AND MEMBERS OF THIS SUBCOMMITTEE, WE BELIEVE THE LEGISLATION INTRODUCED BY CONGRESSMAN JOE KENNEDY ADDRESSES THESE CONCERNS IN A MEANINGFUL AND CONSTRUCTIVE FASHION. IT DOES SO IN A WAY THAT DOES NOT OVERCOMMIT THE FEDERAL GOVERNMENT OR IGNORE THE ROLE OF OTHER PUBLIC DECISION MAKERS.

I FIRST BECAME INVOLVED IN INDOOR AIR POLLUTION IN 1978, WHEN MEMBERS OF OUR UNION, WORKING IN THE JUST-COMPLETED \$14 MILLION DEPARTMENT OF HEALTH AND HUMAN SERVICES BUILDING STARTED COMPLAINING THAT THE AIR INSIDE THIS SO-CALLED STATE-OF-THE-ART STRUCTURE WAS MAKING THEM SICK, TIRED, CRANKY, AND UNPRODUCTIVE. THEY DOCUMENTED THEIR MISERY IN STACKS OF WRITTEN COMPLAINTS IN WHICH THEY RECITED A LITANY OF SYMPTOMS FROM HEADACHES, SINUS PROBLEMS AND STINGING EYES TO DIZZINESS, NAUSEA AND LETHARGY. THEIR COMPLAINTS READ LIKE THIS:

"AIR IS DEAD, HEAT UNBEARABLE."

"LACK OF AIR GIVES ME A HEADACHE AND MAKES ME DIZZY."

"NO FRESH AIR. I HAD TO GO OUTSIDE TWICE TO WAKE UP."

"AIR IS HOT AND DRY AND STALE--AFFECTING MY PRODUCTIVITY TODAY--HEADACHE. OUTSIDE OF THE BUILDING I FEEL FINE."

"BUILDING IS CONTINUOUSLY HOT, DRY AND AIRLESS. WORK ENVIRONMENT IS INTOLERABLY DIFFICULT."

IT WASN'T UNTIL SOME TIME LATER THAT I LEARNED ABOUT *SICK BUILDING SYNDROME*, THE RESULT OF ENERGY CONSERVATION STEPS IN THE 1970s WHEN WINDOWS THAT OPEN BECAME OBSOLETE, AND OFFICE BUILDINGS WERE SEALED TIGHT. IN THIS BUILDING AND DOZENS OF OTHERS WHERE MY MEMBERS WORK, FUMES, POLLUTANTS, GERMS AND ODORS--GENERATED BY PEOPLE, MACHINES AND GENERAL OFFICE EQUIPMENT--ARE TRAPPED AND RECIRCULATED. AT LEAST IN THIS ONE BUILDING, THE HEALTH AND HUMAN SERVICES BUILDING, WE WERE EVENTUALLY SUCCESSFUL IN GETTING THE STATE LEGISLATURE TO APPROPRIATE \$3 MILLION TO REDESIGN AND RECONSTRUCT THE VENTILATION SYSTEM.

HOWEVER, MUCH MORE NEEDS TO BE DONE; THE WORK OF OUR NORTHERN NEW ENGLAND INDOOR AIR POLLUTION COALITION CONTINUES. WE RECENTLY COMPLETED 3,500 INDOOR AIR QUALITY SURVEYS BY STATE EMPLOYEES IN THE STATES OF MAINE AND NEW HAMPSHIRE, WITH THE DATA CURRENTLY BEING ANALYZED BY THE EPA. THE MOST REMARKABLE FINDING OF OUR SURVEY IS THE WIDE DISPARITY IN COMPLAINT RATES BETWEEN BUILDINGS WITH A VENTILATION PROBLEM VERSUS BUILDINGS WHERE THE AIR SEEMS BETTER. WE HAVE ALSO CONDUCTED NUMEROUS SEMINARS, PRODUCED EDUCATION MATERIALS FOR OUR MEMBERS, AND AN EDUCATIONAL VIDEO TAPE DOCUMENTING THE COALITION'S ACTIVITIES AND A NEED FOR US ALL TO WORK TOGETHER TO FIND SOLUTIONS.

OUR GREATEST VICTORY TO-DATE HAS BEEN THE PASSAGE OF INDOOR AIR POLLUTION LEGISLATION, FIRST IN NEW HAMPSHIRE AND FOLLOWED QUICKLY BY THE STATE OF MAINE. THIS LEGISLATION, THE FIRST OF ITS KIND IN THE COUNTRY, REQUIRES THAT ALL BUILDINGS OWNED AND LEASED BY THE RESPECTIVE STATE GOVERNMENTS MEET CERTAIN MINIMUM INDOOR AIR QUALITY STANDARDS. IT IS ENVISIONED THAT THESE STANDARDS WILL BE CLOSELY MODELED AFTER THE RECENTLY-FINALIZED ASHRAE RECOMMENDATIONS.

ONE SUCH RECOMMENDATION CALLS FOR A MINIMUM VENTILATION RATE OF 15 CUBIC FEET PER MINUTE OF OUTSIDE AIR PER BUILDING OCCUPANT.

HOWEVER, MUCH MORE NEEDS TO BE DONE, AND THAT'S WHY WE ARE HERE TODAY TO SUPPORT THIS FEDERAL LEGISLATION, AND COMMENT ON SOME OF THE SECTIONS OF THIS LEGISLATION THAT WE CONSIDER OF GREATEST IMPORTANCE.

FIRST, WE CONGRATULATE THE DRAFTERS OF THIS LEGISLATION FOR ACKNOWLEDGING IN THE "FINDINGS" SECTION THAT INDOOR AIR POLLUTION NOT ONLY POSES SERIOUS THREATS TO PUBLIC HEALTH, BUT ALSO REDUCES PRODUCTIVITY AT THE WORKPLACE. OUR SURVEYS OF STATE EMPLOYEES IN MAINE AND NEW HAMPSHIRE DEMONSTRATE CLEARLY THAT EMPLOYEES WHO WORK IN *SICK BUILDINGS* ADMIT TO REDUCED PRODUCTIVITY. SOME MIGHT ARGUE THAT LOST PRODUCTIVITY IS FAR LESS A HARM THAN A SERIOUS THREAT TO PUBLIC HEALTH, BUT WE HAVE OBSERVED THAT IT IS OFTEN A BETTER STIMULUS FOR CHANGE.

SECOND, THE "FINDINGS" SECTION MAKES SPECIFIC REFERENCE TO BACTERIA AND FUNGI WHICH OFTEN SPAWN INSIDE IMPROPERLY-MAINTAINED AIR VENTILATION SYSTEMS AND CONTRIBUTE TO INDOOR AIR PROBLEMS.

A PERSON WORKING IN A MODERN TIGHT BUILDING IS DEPENDENT UPON THAT MECHANICAL AIR SYSTEM AND ITS DUCT WORK FOR THE AIR HE OR SHE BREATHE, JUST AS YOU WOULD BE DEPENDENT ON AN AIR TUBE IF YOU FOUND YOURSELF UNDER WATER FOR AN EXTENDED PERIOD OF TIME. BEFORE PUTTING THAT TUBE TO YOUR MOUTH, YOU MIGHT ASK HOW CLEAN IT WAS; WHAT WAS IN IT? THIS IS TOO OFTEN OVERLOOKED IN AIR DELIVERY SYSTEMS.

IN CARIBOU, MAINE A MEMBER OF OUR COALITION HAD MOST OF ONE LUNG REMOVED AS A RESULT OF A FUNGUS GROWTH ON HIS LUNG--A FUNGUS OF THE SAME KIND THAT WE FOUND GROWING IN THE AIR DUCTS OF THE BUILDING WHERE HE WORKED.

THIRD, WHILE RESEARCH IS VITALLY IMPORTANT, IT GOES HAND-IN-HAND WITH EDUCATION. WHERE THE FACTS REGARDING THE CAUSES AND CONTROL OF INDOOR AIR POLLUTION ARE ALREADY KNOWN, EDUCATION SHOULD BE A PRIORITY. A MUCH HEAVIER EMPHASIS ON THE EDUCATION OF BUILDING OWNERS, MANAGERS, AND OCCUPANTS IS SUGGESTED.

FOURTH, WE URGE YOU TO EXPAND THE DEFINITION OF "FEDERAL BUILDING" TO INCLUDE NOT ONLY BUILDINGS OWNED BY THE FEDERAL GOVERNMENT, BUT ALSO INCLUDE THOSE LEASED BY THE FEDERAL GOVERNMENT. DURING THE LAST EIGHT YEARS OF BUDGET CUTBACKS, THE GENERAL SERVICES ADMINISTRATION HAS FAVORED LEASING SPACE OVER NEW CONSTRUCTION.

FIFTH, UNDER THE "RESEARCH" SECTION, WE SUPPORT STUDIES THAT WILL ATTEMPT TO QUANTIFY THE COSTS TO EMPLOYERS FROM INDOOR AIR POLLUTION. EXAMPLES OF EMPLOYER COSTS INCLUDE LOST PRODUCTIVITY, SICK TIME USE, INCREASED USE OF EMPLOYER-PAID HEALTH INSURANCE AND WORKERS COMPENSATION CLAIMS. FOR, AS WE HAVE STATED, WE BELIEVE THAT AS WE COME TO APPRECIATE THESE COSTS AT THE WORKPLACE, EFFORTS TO SOLVE THE PROBLEMS WILL BE MORE FORTHCOMING.

SIXTH, WE BELIEVE DEMONSTRATION PROJECTS SHOULD MORE HEAVILY EMPHASIZE THE NEED TO DEVELOP SUCCESSFUL MEANS TO EDUCATE THE PUBLIC ABOUT THESE PROBLEMS. MODEL EDUCATION PROGRAMS THAT PROVIDE EXAMPLES OF BALANCE AND COOPERATION WILL DO

MUCH TO HELP OTHER DECISION MAKERS REALIZE THAT THESE HUMAN PROBLEMS ARE MANAGEABLE.

SEVENTH, AGAIN UNDER THE "RESEARCH" SECTION, WE WOULD ASK THAT YOU DEFINE NONPROFIT INSTITUTIONS AND ORGANIZATIONS TO SPECIFICALLY INCLUDE, ALONG WITH HEALTH AND EDUCATION ORGANIZATIONS, EMPLOYEE ADVOCATE ORGANIZATIONS SUCH AS OUR OWN. WE HAVE FIRST HAND EXPERIENCE WITH THESE ISSUES, AND STAFF THAT INCLUDES HEALTH PROFESSIONALS TO ADDRESS THEM. WE BELIEVE WE CAN CONTRIBUTE.

EIGHTH, MENTIONED IN THE "NATIONAL RESPONSE PLAN" SECTION, WE SUPPORT THE CRITICAL NEED TO PROVIDE CONCISE YET COMPREHENSIVE EDUCATIONAL MATERIALS FOR ALL AFFECTED PARTIES THROUGH THE DEVELOPMENT OF "GUIDANCE DOCUMENTS." ONE OF EPA'S FIRST RESPONSES TO THE ASBESTOS IN BUILDINGS THREAT WAS TO PUBLISH A COMPREHENSIVE DOCUMENT ENTITLED GUIDANCE FOR CONTROLLING ASBESTOS-CONTAINING MATERIALS IN BUILDINGS. WE BELIEVE THIS LEGISLATION SHOULD REQUIRE THE EPA TO PREPARE A SIMILAR "USER-FRIENDLY" GUIDANCE DOCUMENT FOR IDENTIFYING, CHARACTERIZING, EVALUATING AND CONTROLLING INDOOR AIR POLLUTION PROBLEMS.

NINTH, ALSO UNDER THE "NATIONAL RESPONSE PLAN" SECTION, IT IS IMPORTANT THAT CONGRESS SUPPORT THE NEED FOR BUILDING OCCUPANTS AND OTHER AFFECTED PARTIES TO BE ABLE TO REQUEST BUILDING SURVEYS BY EPA OR A DESIGNATED AUTHORITY WHEN INDOOR AIR POLLUTION PROBLEMS ARE SUSPECTED. THESE SURVEYS WILL PROVE HIGHLY BENEFICIAL TO EPA IN FURTHER STUDYING THE FACTORS THAT CAUSE INDOOR AIR PROBLEMS--AND IN IDENTIFYING SOLUTIONS. IT IS IMPORTANT THAT THIS RIGHT TO REQUEST A SURVEY BY EPA SHOULD BE CONFERRED TO ALL BUILDING OCCUPANTS--STATE, LOCAL AND PRIVATE SECTOR--AND NOT LIMITED TO FEDERAL SECTOR WORKPLACES.

TENTH, WE BELIEVE THE TOLL-FREE HOTLINE IN THE "CLEARINGHOUSE" SECTION WILL PROVE TO BE A MOST USEFUL RESOURCE TO THE PUBLIC AS WE STRUGGLE TO DEAL WITH THESE PROBLEMS. UNFORTUNATELY, EXPLICIT LEGISLATIVE LANGUAGE IS NECESSARY AS, FOR EXAMPLE, EPA ELIMINATED ITS TOLL-FREE HOTLINE FOR THE ASBESTOS "ACTION" PROGRAM TWO YEARS AGO.

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FINALLY, WE BELIEVE THE SPONSORS OF THIS BILL ARE TO BE CONGRATULATED ON DEVELOPING LEGISLATION WHICH RECOGNIZES THE RESPONSIBILITY OF FEDERAL LEADERSHIP WITHOUT IGNORING THE LIMITATIONS ON SUCH INVOLVEMENT. LIMITATIONS THAT SPRING NOT ONLY FROM FISCAL CONSTRAINTS, BUT ALSO FROM THE TRADITIONAL LIMITED ROLE OF THE FEDERAL GOVERNMENT IN MATTERS CONCERNING REAL ESTATE PROPERTY AND BUILDINGS.

IN SUMMARY, WE BELIEVE THIS IS A WELL-CRAFTED BILL WHICH DESERVES THE SUPPORT OF THIS SUBCOMMITTEE AND THE UNITED STATES CONGRESS. WE URGE QUICK CONSIDERATION OF THIS LEGISLATION.

THANK YOU.

Mr. SCHEUER. Thank you very much, Mr. Parker. You should know, as the Union rep here, that the EPA has had a number of complaints from its employees in its own headquarters buildings here in Washington in the Waterside Mall complex and other of its buildings in Washington. And they are engaged in a very extensive program of renovating and rehabilitating these buildings that are only 10 or 15 years old, but that have ventilation systems that are far less than adequate, carpets that are toxic. And they have produced a very creditable program of rehabilitation and renovation for those buildings that was employee-stimulated. The employees really have been very unhappy and many of them have suffered serious illnesses as a result of pollution there.

And it's ironic that employees should have stimulated a major rehabilitation and renovation program directed at air pollution in the home offices of the EPA. Now, if that isn't an irony, I don't know it, and I think the Union and the employees at that complex, the EPA employees, can take a great deal of credit for having stimulated this noteworthy program that EPA seems to be doing very much in good faith and bona fide.

With no objection, I'm going to insert this letter in the record at this point in time, and I'll be happy to give all of the members of the panel copies of it for their information and somewhat for their entertainment, too. It's a marvelous irony.

All right, we'll go ahead now with Rosanne Bacon. We're delighted to have you here, both members of Congress from the 8th C.D., New York and Massachusetts. Please proceed for five or six minutes and if you can, chat with us informally knowing that your full prepared statement will be printed in the record.

STATEMENT OF ROSANNE BACON, PRESIDENT, MASSACHUSETTS TEACHERS ASSOCIATION

Ms. BACON. Thank you very much. I am very pleased to be here this morning. I am Rosanne Bacon, I am the President of the 66,000-member Massachusetts Teachers Association, an affiliate of the National Education Association. At present, I reside at 146 West Main Street in Ware Massachusetts, which is on the other side of Massachusetts from the 8th Congressional District where I grew up.

I want to thank Senator George Mitchell of Maine and in particular, our own Congressman Joseph Kennedy, II of Massachusetts for beginning to address the very important issue of indoor air quality with this meaningful legislation. And I want to take the opportunity to thank the committee for taking the time to hear the testimony in a careful manner and to deal with this in what is obviously a cooperative and bipartisan effort on your behalf to solve a problem that's very, very important to all of us.

I am before you today for two reasons. First, to urge your support of House bill 5373, the Indoor Air Quality Act. Indoor air quality has been a very important priority of the Massachusetts Teachers Association and the NEA for many years. The health and safety of the environment in which we teach our nation's children is a critical part of our consideration of the American education system and its problems in our attempt to reform not just the edu-

cation system but the environment in which we attempt to carry out that reform.

We in Massachusetts have witnessed numerous cases across the Commonwealth of insufficient or non-functioning ventilation systems, toxic fumes in the educational atmosphere, excessive heat buildup in classrooms and other air quality issues which have led to health problems for our children and our educators.

And I am going to divert from my prepared testimony here for a minute to address something that I've heard come up several times in the past hour as I've sat here to listen, and that is the issue of cost. And I would put forth to you that cost is an issue that I'm used to dealing with as president of the union, in the context of the cost of our salaries to local communities, the cost of education reform and certification issues, and teacher preparation on a state-wide level. But I hope that you do not consider the cost simply in dollars of changing buildings and ventilation systems, but that you will constantly keep in mind the cost to our children in lost hours in education that can never be made up when they are out sick due to viruses caused by—as was pointed out before—fungi in the ventilation systems and the very air that they breathe. And that's a cost that you can't count in dollars and cents, and I hope that you will keep that in mind.

My second reason for being here today is to introduce you to Kathleen Clinton, a member of the Massachusetts Teachers Association who has very unfortunately witnessed the harmful effects of an unhealthy environment in the workplace herself. Kathleen, thank you very much.

STATEMENT OF KATHLEEN CLINTON, MEMBER, MASSACHUSETTS TEACHERS ASSOCIATION

Ms. CLINTON. Thank you, Rosanne. Mr. Chairman and members of the committee, for the record my name is Kathleen Clinton and I reside at 340 Hurley Street in East Cambridge, Massachusetts. I am an English teacher with over 20 years of service at Cambridge Ringeon Latin High School. I am a member of the National Education Association, the Massachusetts Teachers Association and the Cambridge Teachers Association.

First, let me thank you for the opportunity to share with you the physical and emotional harm that I and many of my colleagues have suffered as a result of an unsafe school building environment. I am not an expert on the proposed legislation before you; I am an expert educator and an expert witness on the effects of an unchecked, hazardous air quality environment.

At present, there are 18 indoor air quality cases from Cambridge alone that are pending arbitration. They involve numerous cases of air quality-related illnesses including chronic fatigue, chronic sinusitis, repeated ear infections leading to protracted or damaged ear drums and hearing loss; laryngitis; pneumonia; increased asthmatic occurrences; colon dysfunctions and excessive abdominal swelling; miscarriages and other reproductive disorders.

Other communities such as nearby Somerville and Belmont have experienced similar difficulties due to improperly working heating

and ventilation systems. But perhaps I can most effectively accentuate this problem by relating my own personal situation.

In 1979, Cambridge Ringeon Latin opened its partly new and partly renovated doors for students and teachers. An industrial-sized greenhouse was situated on the third floor of this facility on the east side of the building. Due to this unusual location, the heat buildup on the renovated section was inordinate, causing the insulation to burn out, walls to crumble and crack and ceiling tiles to fall off. Malfunctioning exhausts, unventilated corridors and plumbing vents situated near air intakes led to a proliferation of toxic fumes made more unendurable by heat buildup and high CO₂ rates. In addition, toxic fumes and organic materials from sheet metal, carpentry, welding and photography shops and science labs were being recirculated into the building. This was my environment, my workplace.

As a result, these last 10 years have not been pleasant ones. I suffer from Epstein Barr virus, excessive swelling due to thyroid damage, blepharitis, which is damage to the lining of my eyes, and numerous other physical ailments.

I believe that passage of the legislation before you, which will expand and strengthen research of indoor air contaminants, is a vital step toward protecting our nation's children and educators from an unhealthy environment. I have come to Washington, D.C. today at the invitation of my Congressman, Joseph P. Kennedy, II, to ask you, the members of this committee, to support 5373, the Indoor Air Quality Act of 1988, and not let what has happened to me, my colleagues and our students continue to happen to others.

Thank you for listening.

Mr. SCHEUER. Thank you very much.

I will recognize Congressman Kennedy.

Mr. KENNEDY. Thank you very much, Mr. Chairman.

First of all, I want to thank Kathleen for your testimony. I know it is difficult for you to come down and discuss personal health problems, but I think it is very important, for not only you and your fellow teachers but particularly for the children that you are educating, that you take the time, and you are to be commended for doing something that takes courage. So I appreciate your coming down.

Rosanne, I wondered if you might tell us whether or not the kind of testimony that Ms. Clinton has provided is really something that is just specific to only that particular school or whether or not, as somebody who heads a 66,000 teachers organization, whether or not these are complaints that you hear often, and if they are, about what kind of pace do you hear, what kinds of complaints do you hear just in running that union?

Ms. BACON. Although it is always difficult to hear personally anybody's testimony, I wish that Kathleen were the only one that was coming to me with problems like this. It also would be easier to deal with if you were listening only to teachers talk about themselves because as adults, you can make suggestions. They have the ability to fight about it. I think, Congressman Scheuer, when you brought even that with the EPA, the building that was built 15 years ago, that the employees there have problems, that is a time

when we built buildings all over the Commonwealth, and the buildings of that generation are the problem buildings.

I hear it from all over the Commonwealth, throughout all of the congressional districts, especially in the areas where there has been significant buildup in the last 15 or 20 years in the southeast. Attleboro has had terrible problems, Taunton terrible problems. As Kathleen mentioned, Somerville and Belmont, the area fringing 128, the whole area where we have been fortunate to have the high tech buildup, the schools that were built then have caused us significant problems.

They have been problems not just for the teachers with their own health but their attempts to create an atmosphere in which they can conduct reasonable educational activities. Even in my own town, a small town in Ware, we built an elementary school with a closed ventilation system, with the obvious intent that it would have air conditioning that would work, and that you would have a heating system that would work, and that everything would be environmentally controlled.

However, immediately after that or very quickly after that, with the passage of Proposition 2.5, local communities had to start cutting budgets, and in many instances, although heat in the Northeast is never considered to be a luxury, air conditioning is considered to be a luxury, so they stopped funding in the local budgets the money for the air conditioning system.

Now you have yourself faced with actually four months out of the ten, anyway, where that building is not habitable. All of the doors have to be open. Teachers have to take the kids outside in many instances simply to be able to breathe at all. There have been instances when we have had to send kids home not because of any registration of pollutants in the atmosphere but simply because the heat gets to be 100, 105 degrees and there is no movement of air, no ability to have the air moved.

We are lucky in Ware. We have a superintendent who simply says: That's it, get them home, send them someplace else, we have set up other places where they can learn. But that's not true everywhere, and it is a significant problem.

Mr. KENNEDY. Thank you very much.

Mr. SCHEUER. The savings that you have just described on air conditioning, it seems to me, exemplify the saying "Penny wise, pound foolish." Here we are investing millions and millions of dollars in a school system, in a beautiful new school building, and just for the want of perhaps a few hundred thousands of dollars, a very small percentage of the total building, that building is uncomfortable for many days, perhaps, and absolutely incapable of being used for many other days.

Now, that is a totally cost-ineffective policy. It is very poor public policy making for a school board to make that kind of an absurd saving that is so very expensive in the long run. If you look at the lifetime cycling of that cost, you will find we paid back and lost tens and tens times what it would have cost to have completed that building properly in the first place.

Ms. BACON. Plus in situations if you look around you now, even with a room like this that is so pleasant to be in, you know yourself—it might not always be that way, Congresswoman, but it is

today—if you stop and think about how often you would like the opportunity to get up and move around because you find yourself perhaps not quite always being able to pay attention, and you think what it is like to be in a smaller room with a less carefully controlled atmosphere or less carefully controlled temperature with 30 adolescents and attempt to try and keep them interested in what they are doing and in what you want to happen, you can see that the problem is compounded. The health issue is the most significant.

Mr. SCHEUER. Thank you, Ms. Bacon.

We do have a roll call vote. I am going to recognize Ms. Schneider from Rhode Island for about two minutes. Then I am going to take a minute to ask you all a question, and then I am going to leave and let you all answer the question for the record.

Do you disapprove of that?

Ms. SCHNEIDER. I would love to hear the answer to your question now that you have spurred our curiosity.

Mr. SCHEUER. Why don't I ask the question now, then.

A recent article in *Scientific American* argues that we should accept a higher level of risk from indoor air pollution and from all of the other traditional types of pollution. The question is raised: "After all, radon poses a much higher risk than traditional problems; still, it is roughly equivalent to the risk of suffering an accident in the home." This type of reasoning would say are normal levels of indoor air pollution simply one of the moderate risks of life that we should take in our stride and be good sports about? The reasoning would be we get up in the morning and we take risks the minute we get out of bed, from the food we take, crossing the street, going to the office. Life is full of risks, and should we sort of be philosophical and accept these risks of indoor pollution?

Any of you.

Mr. PARKER. Are you asking for an answer now?

Mr. SCHEUER. Yes, briefly.

Mr. PARKER. Briefly. I guess the only first reaction I would have in response to that would be the fellow who jumps off the Empire State Building and halfway down says, "It doesn't hurt yet." I don't understand that kind of logic because evidently individuals will be deeply affected in the long range. Certainly it is not a problem that you can easily sweep under the rug, if you will excuse the pun.

Mr. SCHEUER. Ms. Eskin.

Ms. ESKIN. I have a couple of comments about that position. One is that there are so many risks that we all face in our daily lives, so many that we have no control over and some that we do. I think many of the problems posed by indoor air pollution are controllable risks, so I think you have to look at your risks relatively.

Mr. SCHEUER. Easily and inexpensively controlled.

Ms. ESKIN. Easily and inexpensively. Second, it is a decision that I think each consumer should be allowed to make. We are talking about the threshold issue of educating the public about the risk, and if it is easy to educate them and easy to solve, I think that is a decision that the consumer should make.

Ms. BACON. And although you can control the quality of the air, the truth of the matter is that none of us can control the fact that

we breathe. I can control every single step I take. I can decide to go from one end of the room to the other. I can decide whether or not to cross the street in the middle of the street or at the corner. I can decide what car to buy, what food to eat. But none of us can control the fact or for very long control the fact that we have to breathe.

Ms. CLINTON. As an educator, I am encouraging students not to begin smoking cigarettes, and if they do, perhaps they can stop. Adults are being encouraged as well. That is another issue you can look at as taking a risk, but I still think we are better off encouraging the students and adults either not to start smoking or to give it up. So it is almost a comparable situation.

Mr. RODEMEYER. Thank you. The subcommittee will stand in recess for about ten minutes.

[Recess.]

Mr. SCHEUER. We will come to order.

Ms. SCHNEIDER. Ms. Eskin, I just wanted to commend you, and certainly the Federation of America because, I believe, and I hope I will be corrected if I am not correct, but I believe that you were the first organization on the block to set this indoor air pollution as your number one priority. I commend you for that preemptive move with great foresight.

Let me say that your efforts, I think, have brought us a long way, and I still see that there is work for you to do in addition to the work that Congress is doing. Before I delineate what I perceive as your job description—since everyone is always coming here and telling us what we need to do, I thought I would toss the ball back in your court, too—I would like to ask Ms. Clinton a question.

When you found a variety of different symptoms, had you assumed that it had some relevance to the indoor exposure?

Ms. CLINTON. Not for several years no, Ms. Schneider.

Ms. SCHNEIDER. Not for several years.

Ms. CLINTON. I wasn't sure.

Ms. SCHNEIDER. How is it that you eventually came around to recognizing the connection?

Ms. CLINTON. What was easily discernible right away in the building when we went in the spring of 1979 where I was by that greenhouse on the east side, was that it was very hot and stuffy. The students were always complaining even though each group would be there for 45 minutes. I was there all day. When we started up again in the fall, students' eyes would burn and they would get infections. I was trying to discern whether or not that was why I was getting ill.

Ms. SCHNEIDER. The chairman just alerted me that we need to wind down this panel, but just quickly, can you tell me, did you go to several doctors, one doctor? How were they able to define the connection between the indoor air pollution and your problems?

Ms. CLINTON. This was after there had been about 70 teachers involved in a health grievance, and we got more information from MASSCOSH, an environmental group, making links.

Ms. SCHNEIDER. That is useful to know. I was not aware that it was the critical mass that was moving. It seems to me that once again there is this public awareness challenge that we face. We held our first hearings on this topic, and the chairman and I were

attempting to expand public knowledge on this easily four years or so ago, but I am sure that to this day, I get letters and people are completely unaware that there is such a thing and such a problem as indoor air pollution and its health effects.

So insofar as the Consumer Federation is concerned, I think you, in conjunction with EPA and any other organization or labor union or whatever, really has a responsibility to help get the word about because it astounds me to see that we still have so much more to do, and make sure that we not only talk about the problem but, as I said earlier, we must point out that there is a solution that is low cost and requires very little effort.

I think that we will be holding more hearings on this at a later time, and one of the groups that unfortunately we are not hearing from today are the architects. So that we have both remedial action that needs to be taken as quickly as possible but we have to take some proactive action. There is no question that we must continue to build energy-efficient buildings, but the fact remains that we must do it with this new knowledge and technology that is available.

So I just wanted to encourage the Consumer Federation to keep on with your efforts and keep this issue as your number one priority, and let's see how we can do more to bring public attention to the solutions.

Thank you, Mr. Chairman.

Mr. SCHEUER. Thank you, Mrs. Schneider, and thank you very much, all the members of the panel, for a very, very interesting and exceptionally informing panel. We are grateful to you for coming here today. We are especially grateful to Ms. Clinton for her extraordinary efforts and courage in standing up under the brunt of these building-induced sicknesses and for having the will to come here today and illuminate us.

Ms. CLINTON. Thank you. I am honored.

Mr. SCHEUER. We are very, very grateful to you all.

Now we will go on to Panel III: Michael J. Hodgson, Vice Chairman of the Environmental Health Committee of ASHRAE. I don't like acronyms that aren't spelled out. What is ASHRAE?

Mr. HODGSON. The American Society of Heating, Refrigerating and Air Conditioning Engineers.

Mr. SCHEUER. Thank you. Michael McCabe, representing the International Council of Shopping Centers. John Welch, Safe Buildings Alliance. Douglas Greenaway, Vice President for Government Affairs of Building Owners and Managers Association International.

Mr. Greenaway, I understand you have to get away for a plane, so why don't we recognize you first. Hopefully, all of you will just chat with us for five or six minutes each, liberating yourselves from the printed page if that is at all possible. Of course it goes without saying that your prepared statements will be printed at the point in the record in which you testify.

Mr. Greenaway.

STATEMENTS OF DOUGLAS GREENAWAY, VICE PRESIDENT, GOVERNMENT AFFAIRS, BUILDING OWNERS AND MANAGERS ASSOCIATION INTERNATIONAL; DR. MICHAEL J. HODGSON, VICE CHAIRMAN, ENVIRONMENTAL HEALTH COMMITTEE, ASHRAE; WILLIAM H. MCCABE, JR., INTERNATIONAL COUNCIL OF SHOPPING CENTERS; JOHN WELCH, SAFE BUILDINGS ALLIANCE.

Mr. GREENAWAY. Thank you very much, Mr. Chairman. I have summarized my comments and I will try to be as brief in going through them.

Mr. Chairman and members of the subcommittee, I am Douglas Greenaway. I am an architect and vice president for government affairs with the Building Owners and Managers Association International.

I want to commend you, Mr. Chairman, and your subcommittee for scheduling the hearings and for your interest in this issue, Congresswoman Schneider's interest in this issue. The congresswoman might recall that four years ago she spoke at a BOMA conference on indoor quality issues in Boston.

BOMA shares your concern that a comprehensive and coordinated program of research and development is needed if we are to identify the nature, cause and extent of indoor air contaminants and reduce the effect they may have on human health. The success of any building owner or manager is predicated on their ability to provide safe, healthy buildings and workplace environments.

BOMA is committed to research on indoor air contaminants and will continue to take the lead in identifying problems and solutions. BOMA is the oldest and largest trade association representing the office building industry, with 100 federated associations in North America and abroad. We represent 6800 members who own or manage 5 billion square feet of space in North America.

In efforts to comply with legislated energy conservation guidelines and to lower energy costs, building managers have resorted to tightening buildings, shutting down air conditioning systems at night and on weekends, automatic temperature controllers to cycle fans on or off, or installed systems such as variable air volume systems.

These efforts have made important contributions toward saving global energy supplies, but they have not been without consequences. Shutting down air conditioning systems at night and on weekends, for example, may result in Monday morning complaints of building odors. In some instances, variable air volume systems have permitted the introduction of stale air into occupied spaces.

Concerns with these consequences and the consequences of energy conservation efforts have led BOMA International to join with other industry groups under the auspices of the National Research Council in designing a guideline entitled "Policies and Procedures for Control of Indoor Air Quality."

In another study scheduled to be published soon, BOMA cosponsored, along with my colleagues at ASHRAE, scientists from the Georgia Institute of Technology, an examination of three office buildings. The researchers, among other things, hoped to determine whether or not there are significant differences in the levels of indoor air pollutants in the three facilities which were built using

different finish materials and products, different ventilations systems, and have different smoking policies.

In 1987 BOMA participated, along with scientists from 35 countries, in the United Nations World Health Organization sponsored Indoor Air '87 Conference in Berlin, and this year I was invited to present a paper on behalf of our industry in the joint U.N.-World Health Organization, Conciel Internationale du Betimon conference on health buildings in Stockholm.

BOMA International is pleased to co-sponsor, along with the United Nations World Health Organization's Environment Canada, the U.S. EPA and ASHRAE Indoor Air '90, which will be held in Toronto, Canada.

The Senate Committee on the Environment and Public Works has already moved to report out a sound, well-reasoned indoor air quality bill, S.1629. BOMA, along with our colleagues in the Real Estate Industry Working Group, worked closely with the committee to refine the legislation, incorporating many of our suggestions and comments.

Before I share with the subcommittee a description of BOMA and the Real Estate Industry Working Group's input into S. 1629, I would like to touch upon two important points relative to indoor air quality legislation. First, I strongly urge this subcommittee to pursue an objective discussion on the causes of indoor air problems. Where building-related indoor air problems exist, they are often sensationalized by misappropriated labels such as "Sick Building Syndrome."

The value of rational solutions has been diminished. In many instances, indoor air problems can be directly traced to specific causes. More often than not, correction of air quality problems can be addressed by simply replacing a building component or readdressing a maintenance issue.

Research indicates that serious air quality problems are relatively rare in multi-tenant commercial office buildings and that they are more frequent among single-tenant buildings. Research also suggests that buildings which experience air quality problems are the exception, not the rule.

Where complaints exist, some are within the capability and resources of the building owner and manager to address. Many general working conditions which affect an employee's level of workplace satisfaction, however, are beyond the purview of the owner or manager but the responsibility—and this is critical—of tenants, design professionals, contractors, product manufacturers and others.

Employee smoking habits, for example, resulting in discomfort to non-smokers may suggest the need for tenants to address office-wide smoking policies. In some tenant spaces, tenant furnishings or finished products and occupant densities can become a primary source of contamination. Where occupant densities exceed a ventilation system's design capacity, complaints are bound to result.

Clearly, tenant solutions may include an evaluation of interior space plans and perhaps a reconfiguration of those plans. For the building manager, steps to improve thermal comfort and to increase minimum levels of outside air may be useful in reducing air quality complaints. For most existing buildings, BOMA suggests a

few easy steps which can be taken to avoid air quality problems. These might include an alert building management educated and oriented to sensitive issues such as indoor air quality, effective and responsive communication between management and tenants, staff trained to deal with IAQ issues and maintaining adequate levels of outside air temperature and acceptable air movement.

Mr. SCHEUER. Mr. Greenaway, we are running a bit over time, if you could try and bring your remarks to a conclusion.

Mr. GREENAWAY. Whatever the case, BOMA is committed to healthy and safe workplace environment.

A second point I would like to address is the regulatory nature of the current pending indoor air quality legislation. It is BOMA's position that such measures effectively create a new regulatory program.

Mr. SCHEUER. Mr. Greenaway.

Mr. GREENAWAY. I am about to conclude.

Mr. SCHEUER. Very good.

Mr. GREENAWAY. BOMA supports H.R. 5373 and we are particularly pleased with the inclusion of several points which were reported out of S. 1629. In considering H.R. 5373, we would appreciate the adoption of language which would allow NIOSH to release its final report to building owners 30 days prior to final release.

Finally, BOMA, along with members of the Real Estate Working Group, welcome the opportunity to work with the subcommittee in fashioning a coordinated program of indoor air quality research. We recognize our responsibility to be a part of the solution and provide indoor air quality environments for our employees, our tenants and their employees.

Because I must leave for Canada shortly, I would be pleased to answer a few questions and then respond in writing for the record.

[The prepared statement of Douglas Greenway follows:]

BOMA

Indoor Air Testimony before the House
Science, Space and Technology Subcommittee
on Natural Resources, Agriculture Research and Environment
Wednesday, September 28, 1988
9:30 am. in 2318 Rayburn HOB

Mr. Chairman, members of the Subcommittee, I am Douglas Greenaway, Vice President for Government Affairs with the Building Owners Managers Association (BOMA) International. I would like to begin my testimony by commending you and your subcommittee for scheduling this hearing on indoor air quality legislation, specifically H.R. 5373. BOMA supports and shares your concern that a comprehensive and coordinated program of research and development is needed if we are to identify the nature, cause and extent of indoor air contaminants and reduce the effect they may have on human health.

Indeed, the success of any building owner or manager is predicated on their ability to provide safe, healthy buildings and workplace environments. As such, BOMA is committed to research on indoor air contaminants and will continue to take the lead in identifying solutions.

Founded in 1907, BOMA is the oldest and largest trade association representing the office building industry, with 100 Federated Associations in the United States, Canada, and around the world. We have 6,800 members who are office building developers, owners, managers, service companies, brokers and investors, who own or manage 5 billion square feet of office space in North America. Approximately 60 percent of our members are property managers, the remaining 40 percent are owners of commercial property.

In efforts to comply with legislated energy conservation guidelines and to lower energy costs, building managers have resorted to tightening buildings, and shutting down air conditioning systems at night and on weekends. To save energy, automatic temperature controllers are often used to cycle fans on and off during the day. In other energy conservation efforts HVAC systems designers have specified the installation of variable air volume (VAV) air systems. Attempts to save energy through the redesign of HVAC systems have made important contributions toward saving global energy supplies.

But these mandated efforts have not been without consequences. Shutting down air conditioning systems at night and on weekends may result in Monday morning complaints of building odors. Without proper maintenance, vibrations from the start-up of cycle fans may cause dirt to be dislodged and carried into occupied areas. In some instances VAV systems have permitted the introduction of stale air into an occupied space. When supply fans are throttled back for energy savings, exhaust fans may not be reduced at the same rate. The exhaust fan may force more air into the "returnair/freshair" mixing box than the supply fan can accommodate. This may cause the return air to exhaust out of the building through the fresh air intake creating a situation where fresh air is prevented from entering the building through the HVAC system.

Concerns with the consequences of our energy conservation efforts led BOMA International to join with other industry groups under the auspices of the United

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States National Research Council's Building Research Board in designing a guideline entitled "Policies and Procedures for Control of Indoor Air Quality."

In another study scheduled to be published soon, BOMA co-sponsored, along with the American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE), scientists from the Georgia Institute of Technology in an examination of three office buildings.

One building was built by a developer with concern for hyperallergenic occupants. "Natural" construction and finish products were incorporated in the building's design. Smoking in the building is prohibited. Ventilation systems have been designed to provide maximum opportunity to expel pollutants that may come from business equipment.

The other buildings were designed and constructed using routinely specified construction and finish materials and products. Smoking is not prohibited. Ventilation systems have been designed using standard design criteria.

The researchers, among other things, hope to determine whether or not there are significant differences in the levels of indoor air pollutants in the three facilities.

In 1987, BOMA participated, along with scientists from 35 countries, in the United Nations World Health Organization's (UNWHO) sponsored "Indoor Air '87" conference in Berlin and this year I was invited to present a paper on behalf of our industry at the joint UNWHO/Conseil International de Batiment (CIB) conference on "Healthy Buildings" in Stockholm. BOMA International is pleased to cosponsor along with the United Nations World Health Organization, Environment Canada, and the U.S. EPA "Indoor Air '90" which will be held in Toronto, Canada.

As you are aware, the Senate Committee on Environment and Public Works has already moved to report out a sound, well-reasoned indoor air quality bill, S. 1629. BOMA, along with our colleagues in the Real Estate Industry Working Group, (made up of members and staff from the National Realty Committee, the Mortgage Bankers Association, the International Council of Shopping Centers and the National Association of Realtors) worked closely with the Senate Environment and Public Works Committee to refine S. 1629 while upholding the goals of the legislation. The Senate Environment Committee unanimously approved the measure, incorporating many of our suggestions and comments.

Last year, BOMA was instrumental in organizing the Working Group. As a way to provide a vehicle for examining environmental questions which impact upon the commercial office building industry. Our goal is to share information and build a consensus approach to these sensitive and critical issues.

Before I share with the subcommittee a description of BOMA and the Real Estate Industry Working Group's input into S. 1629, I would like to touch upon two important points relative to indoor air quality legislation. First, I strongly urge this subcommittee to pursue an objective discussion on the causes of indoor air problems. Where building related indoor air problems exist they are often sensationalized by misappropriated labels such as "sick building syndrome." The

value of rational solutions has been diminished. In many instances indoor air problems can be directly traced to specific sources such as heating, ventilating and air-conditioning (HVAC) systems, tobacco smoke, carbon monoxide, ceiling tiles, wall paper, carpets, furniture, flush toilets, humidifiers, pressed wood products, textiles or insulation. More often than not, correction of an air quality problem can be addressed by simply replacing a building component or readdressing a maintenance issue.

Research indicates that serious air quality problems are relatively rare in multi-tenant commercial office buildings and that they are more frequent among single tenant buildings. Research also suggests that problems are rare in small buildings and unusual in buildings where there are windows in every workstation. Buildings which experience air quality problems are the exception, not the rule. Where complaints exist, they may be attributable to discomforting temperature or humidity levels, objectionable odors or poor air circulation. Some of these are within the capability and resources of the building owner and manager to address. Many general working conditions which affect an employee's level of workplace satisfaction are beyond the purview of the owner or manager but the responsibility of tenants, design professionals, contractors and others.

Employee smoking habits resulting in discomfort to non-smokers may suggest the need for tenants to address office-wide smoking policies. Nevertheless, some of our members who occupy all or large portions of their own facility have adopted restricted smoking guidelines or outright bans on smoking in the workplace.

In some tenant spaces tenant furnishing and occupant densities can become a primary source of contamination. Where occupant densities exceed a ventilation system's design capacity, complaints are bound to result from activities such as smoking or eating in the workplace. This may be combined with general feelings of stuffiness and warmth due in part to the close proximity to one's colleagues. Clearly, tenant solutions may include restrictive smoking policies, an evaluation of their interior space plan and perhaps a reconfiguration of that plan.

For the building manager, steps to improve thermal comfort and to increase minimum levels of outside air may be useful in reducing air quality complaints. Revised operational practices, though they may result in increased energy consumption, may prove a wise decision.

For most existing buildings BOMA suggests these few easy steps which can be taken to avoid indoor air quality problems:

- an alert building management educated and oriented to sensitive issues such as indoor air quality
- effective and responsive communication between building management and tenants
- engineering staff trained to deal with IAQ related issues
- maintaining adequate levels of outside air
- maintaining comfortable temperature and humidity standards

- ensuring acceptable air movement
- working with tenants to avoid occupancy densities in excess of a building's HVAC system design capacity
- working with tenants to establish effective, practical smoking policies
- ensuring that adequate attention is given to correct building systems maintenance and operational procedures.

Whatever the case, BOMA is committed to a healthy and safe workplace environment. Without these ingredients, we could not keep our facilities leased. Providing quality indoor air goes hand in hand with satisfying our tenants.

As the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., has stated, "HVAC systems today serve as the lungs of the building, controlling the quality of the air indoors." Clearly, proper design, installation and maintenance of HVAC systems are important factors contributing to the quality of indoor air.

A second point I would like to make addresses the regulatory nature of currently pending indoor air quality legislation. It is BOMA's position that such measures effectively create a new regulatory program. This program would include the listing of indoor air contaminants, the publication of health advisories with concentration levels, Environmental Protection Agency (EPA) supporting actions which will result in the development of regulations, grants to states to develop regulations, building assessment recommendations and measures to reduce pollutant concentration levels.

In spite of comments to the contrary, these measures have the force of regulations and go beyond a research agenda. That being the case, Congress should provide the same legislative guidance to the EPA as it would if it were expressly authorizing a new regulatory program. Standards should be set for listing contaminants and defining safe levels of concentration; establishing responses to contaminant concentrations and providing requirements for adequate public notice and comment.

BOMA supports H.R. 5373, The Indoor Air Quality Act of 1988 and the indoor air quality bill reported out of the Senate Environment and Public Works Committee. We are particularly pleased with the inclusion of the following provisions which were offered by BOMA and the Working Group:

- * the publication of technology and management practice bulletins, including assessments of the effectiveness, feasibility and cost of technologies for control and measurement of indoor air contaminants. Interest groups (like BOMA) with expertise in building management and related fields would have an opportunity to participate in the development of these bulletins;
- * clarification and strengthening of the requirements for public review and comment on various documents provided for in the bill;
- * requirements that the EPA use the latest available scientific information and research in preparing health advisories for indoor air contaminants. The EPA will also indicate when anticipated health effects from low concentrations of indoor air

contaminants are extrapolations of health effects from higher concentrations;

- * shortening of the National Institute of Occupational Safety and Health's (NIOSH) preliminary and final building assessment report times to 6 months each;

- * the definition of occupants to mean employees, tenants, and employees of tenants and their authorized representatives; and

- * the requirements that building assessment proposals not be used as a method of harassment by competitors or others having an economic or other disputes with the building owner.

In considering H.R. 5373, we would appreciate the adoption of language which would allow NIOSH to release its final report to building owners 30 days prior to final release. This would allow owners to reassure tenants that appropriate remedial actions were being taken. It would also allow owners and managers to resolve public relations and liability problems that might arise from the final report.

In conclusion, BOMA, along with members of the Real Estate Industry Working Group, welcomes the opportunity to work with this subcommittee in fashioning a coordinated program of indoor air quality research. To that end, we look forward to continued dialogue with you and your staffs and hope you will call upon our expertise as building owners and managers of commercial office buildings. We recognize our responsibility to be a part of the solution and provide quality indoor environments for our employees, our tenants and their employees.

Mr. SCHEUER. We don't have any questions for you now, Mr. Greenaway, but if we do, we will send them to you by mail. As you have heard, we are holding the record open to give us the opportunity of asking all the witnesses questions by mail.

So thank you very much.

Mr. GREENAWAY. Thank you.

Mr. SCHEUER. Next we will hear from William McCabe, representing the International Council of Shopping Centers. Mr. McCabe, please try and chat with us informally. Liberate yourself from the printed page and contain your remarks to six minutes.

Mr. McCABE. I will try and do that, Mr. Chairman.

My name is William McCabe. I am a partner in New England Development, which is a shopping center development company which operates, owns and develops shopping centers primarily in the Northeast and as far south as Virginia.

I am also the Chairman of the Environmental Issues Task Force of the ICSC, International Council of Shopping Centers, representing 24,000 members owning virtually all but 30,000-plus shopping centers in the United States. We appreciate this opportunity to present our views.

The building owners want to provide safe and healthy structures for building occupants. ICSC supports the efforts by the Federal Government to perform research and disseminate information that will assist its members; however, based on our experience with asbestos, it is clear that if the information disseminated is not sufficiently comprehensive, it can have disastrous results.

Asbestos is the major environmental problem in shopping centers. It has become a serious problem in many commercial buildings because of a misperception about the nature of the health risk. Air tests by building owners and EPA subsequent to the EPA Advisory on Asbestos showed that exposure levels are very low even in buildings with damaged asbestos and are virtually indistinguishable from the ambient levels in the outside air.

The fear created by the asbestos legislation and the asbestos position taken by the EPA have resulted in unjustified removal and adverse environmental, not to mention economic, risks. If the removal is done properly, it increases the health risks to asbestos abatement workers. If it is not done properly, the workers, because of improper removal, the transportation and therefore the general public, and the disposal in improper disposal units for the asbestos increase the health risks.

Further than that, we currently are now involved with installing fibrous fireproofing and insulating materials common used to replace asbestos, such as fiberglass and rock wall, which we currently find rock wall, for example, is now presenting a health hazard and has been determined to be a health hazard by the EPA. My own conversations with EPA indicate that we are probably going to run into the same situation with fiberglass. We run into a situation where the antidote is worse than the poison.

These consequences of asbestos are the result of the content and timing of information disseminated principally by the Federal Government in the form of legislation and regulations and the reports of this information by the news media. This information states that asbestos causes fatal disease at high concentration levels. It was

not accompanied by information clearly identifying the risks at various exposure levels or comparing this risk to other levels in everyday life. It was extrapolated and assumed that low level doses of asbestos were also dangerous.

Radon is similar to asbestos in that they are both carcinogens. Perhaps the most significant difference in the perception of the general public is that the content and timing of the information disseminated by the government was far more plausible and acceptable by the general public.

The EPA reported that radon, while it is a carcinogen with no known levels of exposure at which there is no health risk, also prominently compared the health risks of radon at various exposure levels to other risks of everyday life. EPA also indicated there was an exposure level above zero which was an action level below which remedial action was not recommended.

EPA also described a variety of practical mitigation actions, concluding their costs, the effectiveness and limitations. We are aware and endorse that legislation which soon may be enacted that would direct EPA to provide additional information on the health risks at low concentration levels, but we are also concerned that this legislation is discouraging EPA from suggesting an action level for radon.

We do not believe providing additional health risk information is inconsistent with indicating an action level that does not present an unreasonable risk, given all the relevant information. The lessons of asbestos hopefully will be reflected in changes to this bill that are currently under consideration.

When a substance present in a building is identified as a carcinogen at some exposure level with no known exposure level at which there is no health risk, additional information must concurrently be provided to assist building owners. Where an estimate is made that there is no threshold exposure level below which there is no health risk and the estimate is based on extrapolations rather than epidemiological evidence at low levels, this extrapolation should be clearly indicated and the scientific studies relied upon to reach this conclusion should be referenced.

I note that the Senate committee report recommends exactly this position, and I hope it would be taken into consideration in this bill.

Third, the responses appropriate at various exposure levels should be described at the same time as the substance is identified as a potential health hazard. These descriptions should include the effectiveness, the limitations, and hopefully the costs of the response.

EPA should be encouraged to suggest an acceptable exposure level based on the health risks at that level compared to other health risks. The Technology and Management Practices Bulletins must be concurrent with the health advisory. Last, the state and local governments should not be encouraged to act before EPA has provided sufficient guidance and support to them for the development of an effective and reasoned response.

I will add one more item. I think adequate funds for EPA to undertake these studies and adequate time should be provided in this legislation. I am not all together sure, considering the extent of

these concerns, that the time limit and the dollars are adequate in order to provide sufficient information for the advisories to be issued by EPA.

Thank you.

[The prepared statement of Mr. McCabe follows:]

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**International Council of Shopping Centers**

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Testimony of the**INTERNATIONAL COUNCIL OF SHOPPING CENTERS**

on

the Indoor Air Quality Act of 1988
(H.R. 5373)

Presented by:

William H. McCabe, Jr.,
Partner
New England Development

before the

House Committee on Science, Space and Technology
Subcommittee on Science, Research and Technology

September 28, 1988

I. Introduction

I am William H. McCabe Jr., a partner in New England Development, which develops, owns, and operates shopping centers and mixed-use facilities in several states.

I am also the Chairman of the Environmental Issues Task Force of the International Council of Shopping Centers (ICSC) and I am testifying on behalf of ICSC. ICSC has over 24,000 U.S. members who own virtually all of the 30,000 shopping centers in the U.S. These shopping centers employ almost nine million persons and each month over 90 percent of all Americans over the age of 18 visit a shopping center. Shopping centers account for 54 percent of all nonautomotive retail sales, amounting to \$584 billion, in 3.7 billion square feet of leasable space.

ICSC appreciates this opportunity to present its views on the issue of indoor air quality and the Indoor Air Quality Act of 1988, H.R. 5373.

ICSC would like to make three points in its testimony today.

First, building owners want to provide safe and healthy structures for building occupants. ICSC supports efforts by the Federal Government to perform research and disseminate information that will assist ICSC members in these efforts. However, based on our experience with asbestos, the shopping center industry's largest environmental problem, it is clear that if the information disseminated is not sufficiently comprehensive it can have counterproductive results. The information must enable building owners and occupants to rationally evaluate the extent of the health risk, in comparison to other risks of everyday life, and balance the risk against the potential health risks, technological feasibility, and cost of various remedial measures. Information that only indicates that a substance found in buildings presents a health hazard at some exposure level and that there is no known level at which there are no health risks may result in response actions that are environmentally unsound and economically wasteful.

Second, because of the sensitivity of building owners and occupants to the potential health hazards of indoor air contaminants, the dissemination of health effects information on indoor air contaminants is likely to have an impact on the shopping center industry substantially similar to the enactment of a new regulatory program.

Third, the bill under consideration by the Subcommittee is much improved over the original bill introduced by Mr. Kennedy,

but additional changes or clarifications are necessary in order to avoid producing environmentally or economically counterproductive situations.

II. The Dissemination of Health Effects Information

ICSC's views on indoor air legislation are primarily based on the experience of the shopping center industry with asbestos, the industry's largest environmental problem. The content and timing of the information disseminated by the Government about asbestos has contributed to a situation that is unsatisfactory from both environmental and economic perspectives. In contrast, the way information has been developed and disseminated about another indoor air contaminant, radon, appears to be much more satisfactory. We believe that indoor air quality legislation should be developed with the lessons of asbestos and radon in mind.

A. Asbestos

Asbestos has become a serious problem in many commercial buildings because of a misperception about the nature of the health risk created by the presence of asbestos-containing materials in buildings. There is tremendous pressure to remove all asbestos-containing building materials regardless of their condition or the ability to manage them without release of fibers into the air. Prospective purchasers are reluctant to buy buildings containing asbestos and do so only at steep discounts. Some lenders have formal policies banning loans for any building with asbestos-containing materials. State regulators have adopted extreme positions on exposure levels in the absence of a Federally sanctioned level.

The response of many building owners to these circumstances is to remove asbestos containing material whenever space is vacated by tenants, despite the fact that exposure levels in a properly managed building do not create an unreasonable health risk. Air tests by building owners and EPA show that exposure levels are very low, even in buildings with damaged asbestos, and are virtually indistinguishable from the ambient levels in the air outside the building.

This environmentally unjustified removal has adverse environmental and economic effects. If the removal is not done properly, it increases the health risks to asbestos abatement workers and building occupants. The transportation and disposal of removed asbestos creates additional health risks. The installation of fibrous fireproofing and insulating materials commonly used to replace asbestos, such as fiberglass or rock wool, may present a health hazard similar to asbestos. Finally, the expenditure of enormous financial resources in unnecessary removal actions and unjustified reductions in property values

impede economic growth and tend to discredit legitimate environmental concerns.

These consequences are the result of the content and timing of information disseminated principally by the Federal Government in the form of legislation, regulations, and other health effects data, and the reports of this information by the news media. This information was that asbestos causes fatal diseases at high concentration levels and that there is no known, non-zero exposure level at which there is no health risk. It was not accompanied by information clearly identifying the risk at various exposure levels, comparing this risk to other risks of everyday life, or suggesting at what low level the substance does not present an unreasonable risk considering the risks created by removal and the costs of removal.

B. Radon

Radon is similar to asbestos in most significant respects. Both are carcinogens (although radon is estimated to cause far more cancer deaths than asbestos) which may be present in a building, because of the manner of construction or the building materials used, without knowledge of the building owner.

Perhaps the most significant difference between the asbestos and radon situations is the content and timing of the information disseminated about the problems by the Government. Although EPA has reported that radon is a carcinogen with no known level of exposure at which there is no health risk, EPA also prominently compared the health risks of radon at various exposure levels to other risks of everyday life. EPA also indicated that an exposure level above zero (4 pico curies per liter) was an "action level" below which remedial actions were not recommended, although it made clear that there was a health risk below that level. The action level is based on the health risk at this exposure level compared to other health risks and the technological feasibility and cost of mitigation below the action level. EPA also described a variety of practical mitigation actions, including their cost, effectiveness, and limitations.

We are aware that legislation may soon be enacted that would direct EPA to provide additional information on the health risks at low concentration levels and the technical feasibility and costs of reaching lower levels, and discourage EPA from suggesting an "action level" for radon at which no remedial action need be taken. We support providing more information to allow individuals to assess the significance of the health risk associated with various exposure levels and the feasibility of lowering the exposure level. But we do not believe providing additional health risk information is inconsistent with indicating an action level that does not present an unreasonable risk given all the relevant information. In the absence of such

a "reasonable risk" exposure level, uncertainty about appropriate action may lead some building owners to take no action or others to take actions that may create other health risks or at a minimum waste economic resources.

C. The Lessons of Asbestos and Radon

We believe that the following lessons regarding the development of indoor air quality legislation can be learned from the handling of the asbestos and radon issues.

1. When a substance present in buildings is identified as a carcinogen at some exposure level, with no known exposure level at which there is no health risk, additional information must be concurrently provided to assist building owners and occupants to properly evaluate the health risk in their building and decide upon an appropriate response. Otherwise, a misperception may be created that the substance presents an unreasonable health hazard whenever it is present in any concentration and must be totally eliminated in all cases.

2. The additional information must indicate the level of health risk created by the substance at various exposure levels and compare the risk to other risks of everyday life. Where an estimate is made that there is no threshold exposure level below which there is no health risk and the estimate is based on extrapolations rather than epidemiological evidence at low levels found in buildings, this extrapolation should be clearly indicated and the scientific studies relied upon to reach this conclusion should be referenced.

3. Responses appropriate at various exposure levels should be described at the same time as the substance is identified as a potential health hazard. These descriptions should include the effectiveness, limitations (including any health risks of remediation actions), and costs of the responses.

4. EPA should be encouraged to suggest an acceptable exposure level, based on the health risk at that level compared to other health risks, and technological feasibility of remedial measures.

5. The state and local governments should not be encouraged to act before EPA has provided sufficient guidance and support to them for the development of a reasoned, effective response.

III. The Impact of Health Advisories Dissemination

The impact on building owners of the dissemination of health effects information was graphically demonstrated two weeks ago when the Surgeon General and EPA issued a health advisory on radon. This was the major news story of the day, with coverage

appearing to focus on three points: 1) there is a potential health hazard in many buildings that building owners and occupants should evaluate; 2) EPA has determined the extent of the risk at different exposure levels, compared the risk to other risks of everyday life, and suggested an exposure level to be used as a benchmark in evaluating a reasonable level of risk; and 3) EPA has identified appropriate remedial actions and provided guidance about their effectiveness, limitations, and costs.

We believe that the health advisories issued under indoor air legislation would have a similar impact to the radon health advisory. The information would be immediately and widely disseminated to building owners and occupants and, as a result, would stimulate action by building owners, occupants, state and local regulators, and others to take remedial measures.

We believe that the content of indoor air health advisories would also be simplified by the news media to make it understandable to the average person. This suggests that a health advisory that contains a statement that there is no exposure level at which there is no health risk and does not suggest an action level indicating a level where there is no unreasonable risk will in effect force the total removal of a substance regardless of other factors.

The Committee should, therefore, craft indoor air legislation with the understanding that the information produced will not be used merely by scientists and building professionals, but will stimulate and guide action by building owners and occupants immediately after its release. The health advisories, therefore, should contain, as in the case of radon when its health advisory was issued, complete information on the risk, including a comparison to other risks, a suggested exposure level at which no unreasonable risk exists, and a description of remedial measures, including their effectiveness, limitations, and cost. To do otherwise would risk the creation of other "asbestos" situations.

IV. Indoor Air Quality Legislation

A. General

The overriding consideration in evaluating any provision of an indoor air quality bill should be whether it contributes or detracts from a rational, appropriate response to the potential health risks of indoor air contaminants. Information about the health effects of indoor air contaminants should reduce uncertainty about the nature and extent of health risks of a substance. It should describe the risk at various concentration levels and exposure durations, for different exposure groups where appropriate, and for the substance alone and in combination with other environmental factors. This information should be

based on the latest scientific evidence from all credible sources. Extrapolations made to estimate risk at exposure levels where there is no epidemiological evidence should be indicated as such, and scientific studies relied upon should be referenced for further study.

Information about remedial actions should reduce uncertainty about the appropriate response action under specified circumstances. It should explain the effectiveness, limitations, and costs of each response action.

In developing indoor air quality legislation, therefore, Congress should direct EPA to provide all of the information described above and should provide EPA with sufficient funds and establish appropriate timetables to enable EPA to do the job properly.

B. The Indoor Air Quality Act of 1988, H.R. 5373

The bill pending in the Subcommittee is substantially improved over the version originally introduced by Mr. Kennedy. However, several provisions should be amended or clarified in order to avoid producing environmentally or economically counterproductive results similar to the asbestos situation. Our comments on major provisions of the legislation are as follows.

1. Definition of Indoor Air Contaminant

The bill defines an indoor air contaminant as a substance which "may reasonably be anticipated to have an adverse effect on human health". This is an appropriate standard to guide EPA in listing substances and provides EPA adequate guidance for placing substances on the indoor air contaminants list.

2. Technology and Management Practice Assessment Bulletins

The bill provides for the publication of Technology and Management Practice Assessment Bulletins. This is an essential feature of a program that would produce health effects information on indoor air contaminants and we strongly support the issuance of such bulletins.

The bill provides that such bulletins "shall be published on a schedule consistent with the publication of health advisories ... to the extent practicable." However, providing building owners with guidance on remedial actions concurrently with health effects information is important to avoid inappropriate responses. We therefore believe that this provision should be amended or clarified to provide that absent extreme and compelling circumstances, EPA should be required to publish the

bulletin at the same time it publishes the health advisory on a substance.

3. Health Advisories: Current Scientific Information

The bill requires that health advisories be based on "the most current available scientific and related findings or information and shall be reviewed, revised, and republished to reflect new scientific information" periodically and no less frequently than every five years. We support this requirement.

However, the bill also should make clear that "available information" includes not only U.S. research but also credible research from other countries where it is available. For example, new research on the differential health effects of different asbestos types and fiber sizes, some of it from foreign researchers, should be incorporated into the health advisory on asbestos.

4. Health Advisories: Timing and Funding

It is crucial that an indoor air quality program be implemented properly. This requires that the timetable for EPA's production of health advisories and technology and management practice bulletins be matched to EPA's funding and staff resources for this task.

Congress should consider whether the required number and timing of health advisories, six within 18 months and another six in the next 18 months, at the funding levels provided in the bill will allow EPA to produce advisories and technology and management practice bulletins of adequate quality. It would be counterproductive if EPA were forced by time and budgetary pressures to merely repackage existing research for the health advisories and fail to publish the technology and management practice bulletins at the same time the health advisories are published.

5. Health Advisories: Public Review and Comment

The bill provides for public review and comment of both the list of indoor air contaminants and the health advisories. The bill clearly requires that comments be considered by EPA before issuance of the final contaminants list, but the public review and comment provision applicable to health advisories is somewhat unclear on this point.

The bill should make clear that proposed health advisories should be available to interested persons when the Federal Register notice is published 90 days prior to the date of intended final publication of a health advisory, and that comments will be considered by EPA prior to publication of the

health advisories. In addition, the technology and management practice bulletin that is to accompany the health advisory also should be made available in proposed form for industry comment prior to final publication.

6. Health Advisories: Priorities

The bill does not suggest a method for setting priorities for the production of health advisories. Congress should consider including in the bill guidance for EPA in setting such priorities. We suggest that priority be given to substances where building owners are actively attempting to remedy problems, such as asbestos. This would provide additional guidance and help avoid inappropriate responses.

The same priority-setting principal should apply to grant assistance for state programs.

7. Health Advisories: Contents

The bill specifies the contents of the health advisory. One provision requires the analysis of the health risk at various concentrations, and a separate provision requires a statement of the concentration at which there is "no known or anticipated human health effect, with an adequate margin of safety". Having a separate provision for the "no health effect" exposure level may suggest that is the exposure level suggested or required by the health advisory, when in fact there may be no unreasonable health risk at higher exposure levels.

These two requirements should be combined into one provision to make clear that the exposure/risk analysis show the relationship between exposure and risk at all levels, all the way down to a zero risk level.

8. Health Advisories: Extrapolations at Low Levels

The Report of the Senate Environment and Public Works Committee on the identical bill states that EPA shall indicate when anticipated health effects at low concentrations are extrapolations from health effects at higher concentrations, rather than observed health effects at the low concentrations. We believe this requirement is very important because it allows interested parties to properly evaluate the health advisory and, therefore, believe that this requirement should be included in the legislative language.

The Committee Report also directs EPA to reference the studies on which the health advisories are based in the advisories. This is another very important requirement in assisting interested parties in understanding the health advisory and it also should be included in the legislative language.

9. Building Assessments

The Senate Committee Report recognizes the potential misuse of requests for building assessments and seeks to minimize this. It limits the persons who may request building assessments as those with a significant stake in the building and knowledge about it. It also states that building assessments are not intended to provide competitors or others with an economic or other dispute with the building owner a method of harassment.

An issue of concern regarding the building assessment provision is that recommendations may be made by NIOSH inspectors on appropriate control measures to reduce exposure to a substance before EPA has issued a health advisory or technology and management practice bulletin on the substance. Where existing Federal environmental or occupational regulations are applicable, they should be followed by the inspector in recommending control measures. Where there are no Federal standards, it is unclear on what basis the inspector should make control recommendations, which creates the possibility of inconsistent or inappropriate control recommendations.

V. Conclusion

The production and dissemination of information about indoor air contaminants should be expected to have an immediate and wide ranging impact on the actions of building owners and occupants. Depending on the completeness and timeliness of the information provided, this information can result in safer and healthier buildings or can lead to environmentally and economically counterproductive actions. The committee should evaluate the provisions of indoor air legislation with the problems that have been created regarding asbestos in mind, and should seek to avoid the creation of similar situations regarding other substances. Finally, the bill pending in the Subcommittee should be amended or clarified to insure that information disseminated will advance rather than detract from sensible environmental and economic policies.

Mr. SCHEUER. Thank you very much, Mr. McCabe.

Now we will hear from Mr. Welch.

Mr. WELCH. Thank you, Mr. Chairman. I too will summarize my statement and ask that the full statement be entered in the record.

Mr. SCHEUER. Without objection, so ordered, and that applies to all of the witnesses, as I have said.

Mr. WELCH. I represent a coalition of former manufacturers of asbestos-containing building products, and although Mr. McCabe has spoken with some thoughtfulness and eloquence indeed about the building owners' perspective, I would like to share with you the building product manufacturers' perspective in our experience with the asbestos issue, some of it not very happy, unfortunately.

After about a decade of research on the asbestos in buildings issue, I think it is helpful to summarize for this, asbestos being a paradigm of the problem, what that body of knowledge tells us. First, the actual exposures of building occupants to asbestos fibers is about a million times lower than exposures that existed in factories and shipyards during World War II that have left us with the legacy of asbestos-related disease. Indeed, there is a consistent body of exposure studies which now show that indoor asbestos levels are not different statistically from outdoor asbestos levels in the ambient environment.

Because the exposure levels are so low, it stands to reason building occupants typically are not at significant risk. Here too, there is a consistent body of medical and scientific opinion from the National Institute of Environmental Health Sciences, scientists at New York's Mt. Sinai School of Medicine, British scientists and others that occupants are not at significant risk.

Third, and this is an important lesson for both radon and asbestos, trying to cure the problem is often not as easy as we would like to think it can be. We are finding out that removals, even properly conducted asbestos removals can make the problem worse. They can increase exposure levels inside of buildings for periods up to nine months or more.

We have found, as we have found with radon, that it is extremely difficult to police consultants and removal contractors that are involved in these activities. Finally, and more germane to the legislation, it is very clear that the marketplace is going to respond to the fear even in the absence of any legally binding regulatory standards. That has been the case with asbestos, radon, and I predict it will certainly be the case with future indoor air contaminants.

Accordingly, the Agency and any legislative remedies have to distinguish between the mere presence of these materials and the actual concentrations in air. How is all of the asbestos experience relevant to H.R. 5373? We have five concerns.

One, the bill does not require EPA to compare indoor levels of airborne asbestos or any pollutant with those that are in the ambient outdoor environment. Clearly, the agency's resources ought to be targeted towards identifying those problem situations where levels are significantly elevated above outdoor.

Secondly, the zero risk standard. The zero risk standard, if taken literally, is going to require, as others have testified, total elimination of all substances, even trace amounts, from the environment.

A standard that is more stringent than that which is found in nature runs the risk of not being taken seriously by the public and in that regard would be counterproductive to making informed decisions.

If I could give you a little anecdote about that, for example, California Proposition 65 has a standard for when building occupants should be notified about asbestos-containing materials in buildings. That standard is several orders of magnitude lower than the naturally-occurring asbestos levels in the Napa Valley and other parts of the state, and it does not serve in any useful way for building occupants to understand to what extent they may be at risk in those buildings.

Our recommendation is it would be far more practical to require EPA to identify exposure levels at which contaminants pose a negligible risk to populations.

Thirdly, EPA ought to be required to evaluate early on the safety of various remediation procedures, specifically, before they are recommended to building owners. We don't need to go down the road that we have gone down with asbestos in finding out that the cure may be worse than the problem. The potential in adverse health effects of remediation actions ought to be considered early on in the process before we find out that we are making problems worse for both the workers and the building occupants.

Fourth, the legislation needs to focus on the concerns of construction trade workers, repair crews, maintenance personnel, who by virtue of the work that they do may be more often disturbing materials or in close and frequent contact with ventilation systems that have viruses or funguses or bacteria that are biologically active.

Finally, the role of science in the development of the health advisories. There has been a consistent thread in the testimony today, and that is that science has got to play a greater role in the development of these advisories. Requiring that the plans and the advisories be developed according to the best available science, I think, ought to be a very strong revision in the bill. Certainly this subcommittee and Congress ought to look at novel approaches to getting the best available sciences.

For example, there is under way now a joint industry/private sector research initiative on asbestos issues where the real estate industry and other interested parties will participate with EPA in doing research outside the agency to assure that the top quality science is brought to bear.

Our experience, Mr. Chairman, on asbestos in buildings issues has shown us that science and not fear and not bureaucratic inertia and not economic self interest ought to be the guiding light as we try to illuminate asbestos and other public health problems with indoor air contaminants.

We are certainly committed to working with you, Ms. Schneider and your staff in working towards that end.

Thank you very much.

[The prepared statement of Mr. Welch follows:]

TESTIMONY OF JOHN WELCH
PRESIDENT
SAFE BUILDINGS ALLIANCE

before the House Science Subcommittee on
Natural Resources, Agriculture, and the Environment
September 28, 1988.

Mr. Chairman, I appreciate the opportunity to testify today. My name is John Welch and I represent the Safe Buildings Alliance, a coalition of former manufacturers of asbestos containing building products. Today, I hope to be able to share with you the experience with asbestos in buildings, and what we have learned that may be applicable to the design of an indoor air program. While the companies I represent ceased manufacturing asbestos building materials years ago, they are major producers of other building products that do not contain asbestos.

Asbestos is a naturally occurring mineral once known as the "miracle fiber" for its tensile strength and ability to withstand high temperatures. Not so long ago, local building codes actually prescribed the installation of asbestos materials to protect occupants from fire. Unfortunately, we have since learned that high occupational exposures, such as those suffered by shipyard and construction workers, can increase the chances of disease. Naturally, people became concerned that the presence of asbestos containing materials in buildings might also pose a threat to the inhabitants.

Nearly a decade of study by EPA, independent experts and two scientific commissions of inquiry have led to the following conclusions:

First, the actual exposure of building occupants to asbestos fibers is up to one million times lower than the exposures typically present in asbestos insulation or factory work decades earlier. In most studies, including EPA's recent survey of government buildings with badly damaged asbestos, there is no difference between the low level of asbestos fibers found indoors and that occurring in the outdoor, ambient environment.

Second, these extremely low indoor levels do not pose a threat to building occupants. A comprehensive survey by a special scientific commission for the province of Ontario concluded that, "We deem the risk which asbestos poses to building occupants to be insignificant and therefore find that asbestos will almost never pose a health hazard to building occupants." Scientists Richard Doll and Julian Peto of Oxford University have concluded that, " . . . the environmental health threat from asbestos in buildings is of an extremely low order." Closer to home, Dr. William Nicholson of the Mt. Sinai School of Medicine has characterized the health risk from indoor air exposure as generally very low.

Third, trying to cure the problem by removing asbestos -- even when carefully conducted -- can make the problem worse by actually elevating indoor asbestos levels, as the scraping and tearing of the building material releases fibers into the air. Unfortunately, the diverse nature of the construction industry makes it extremely difficult to police removal practices, which in turn mean that most removals are poorly performed. Both EPA and OSHA have indicated that violation of emission control and worker protection standards are the rule, not the exception.

Finally, it has become clear that the marketplace will respond to public fear even in the absence of legally binding regulatory standards. That is certainly the case with asbestos, where the almost frenzied pace of removals has been accelerated by the failure of the Environmental Protection Agency to distinguish between the presence of asbestos materials and actual exposure to asbestos fibers. Dr. John Spengler of Harvard, one of the nation's leading indoor air scientists, has criticized the EPA's policy as "an irrational response of removing asbestos based completely on its presence," and added that, "costly and potentially more harmful removal has been undertaken irresponsibly." Fortunately, EPA recently has shown signs of moving closer to the scientific consensus on this subject.

How is this experience relevant to the problem of indoor air pollution, as it is defined and addressed by HR 5373? That legislation appropriately recognizes that it is the concentration of airborne indoor air contaminants, rather than the mere presence of in-place building products, that is the proper focus for concern. In addition, we support in principle the concept of trying to organize scientific data about the health effects of indoor air pollution into a format that both the public and private industry can use to make informed decisions.

Nevertheless, SBA opposes the bill as currently written because we believe that it does not provide the EPA with the kind of clear criteria needed to ensure that the health advisories are scientifically valid, provide accurate information about health risks, and identify practical steps to reduce those risks.

First, the bill does not require EPA to compare indoor levels of specific pollutants with those in the ambient, outdoor environment. Surely, EPA's resources ought to be targeted toward identifying those situations where indoor contamination levels are significantly elevated above those found in the ambient environment. Comparing indoor to outdoor levels of pollution is also the first step toward accurate identification of the causes of pollution. Where

the real sources of the problem lie outside the building or its ventilation systems, it would be unfair -- not to mention impractical -- to make building owners responsible for their control.

Second, the bill requires that EPA identify a "zero-risk" level for all contaminants. A zero risk standard, if taken literally, would require the total elimination of all substances -- even trace amounts -- from the environment. We share EPA's view, as expressed in testimony before the Senate Environment Committee, that attainment of such a zero-exposure standard would be impossible, as many of those contaminants are found in the natural environment at low background levels. A standard that is more stringent than that found in nature runs the risk of not being taken seriously.

It would be more practical to require EPA to identify those exposure levels at which contaminants posed a "negligible risk" to populations. This standard has already been endorsed by the Natural Resources Defense Council as an appropriate basis for regulating pesticide residues in food. It is also a concept that is well understood by scientists, and has provided a basis for controlling environmental risks in other areas.

Third, EPA should be required to evaluate the relative

safety of various measures that may be used to control indoor air hazards, before they are recommended to building owners. EPA is just now beginning to respond to warnings from scientists in the U.S. and other countries that removal of asbestos may be dangerous to your health. The recent epidemic of illegal removals in New York City and California, in which homeless, unprotected workers tore asbestos materials out of apartments and public buildings, demonstrates the difficulty of controlling the quick-buck artists always ready to take advantage of the public's fear. It is not enough for a control measure to be technically feasible. It should also be safe to the workers carrying it out, and yield some measurable benefit to the public health.

Fourth, the legislation could be strengthened by recognizing the special subpopulation of construction trade workers and repair crews, whose occupation may require repeatedly disturbing building materials, or close and frequent contact with ventilation systems. These individuals may be at greater risk than building occupants, if their occupations require the frequent disturbance of materials that may be the source of contamination. SBA believes that workers have a right to be informed of these potential hazards, and to be fully protected from their consequences.

Finally, the role of science in the development of the

health advisories required by the bill should be made more explicit. This could be done by requiring that the advisories and the response plan be developed according to the "best available science." In addition, a formal mechanism could be established to review scientific data from sources outside the agency. It would drive home the point that science - not public fear, bureaucratic inertia or economic self interest - should be our guiding light as we try to illuminate public health problems and their solutions.

There is little question that the issue of indoor air quality should and will receive serious attention in the Congress. As keeper of the flame of scientific inquiry, this Committee is uniquely qualified to ensure that we respond to this new challenge with actions informed by knowledge. We welcome the Committee's interest in this important issue, and look forward to working with you.

Mr. SCHEUER. Very good. Thank you very much, Mr. Welch.

Now we will hear from our last witness, Dr. Michael J. Hodgson, Vice President of the Environmental Health Committee of ASHRAE.

Dr. HODGSON. Thank you, Mr. Chairman and Ms. Schneider, for the opportunity to comment on the proposed legislation. Ms. Schneider is actually well-known to ASHRAE too as she addressed one of our summer meetings some years ago.

ASHRAE is a society of some 50,000 members, including consulting engineers, contractors, design professionals, manufacturers and employees of academic and research institutions.

I am here speaking for them. My role at the University of Pittsburgh is I am an assistant professor of medicine and of industrial environmental health sciences and run the Occupational and Environmental Medicine Program. I have involved in indoor air quality research since 1981 when I investigated several buildings in D.C., including the building next door, the Humphrey Building, and Columbia Plaza. I have published extensively in the field in peer review literature and written numerous reviews.

I became involved in ASHRAE because it is actually the only organization in the United States that has consistently had an interest in indoor air quality. In fact, its Standard 61, Ventilation for Acceptable Indoor Air Quality, is the only consensus standard that even addresses air quality in the U.S.

ASHRAE strongly supports the bill, H.R. 5373. I would like to emphasize two features of that bill that we especially strongly support and then comment on two additional things for your consideration. First, research. A major thrust of this bill is research. Government has to take a leading role in funding such research, particularly in the area of health effects and in the area of contaminant measurements. The private sector cannot accomplish all of the research needed in those two areas, although it can disseminate and apply the results of that research.

ASHRAE has a research budget of about \$1 million a year over the last four years. About 8 percent of that has been spent on air quality research, but that amounts to three or four studies.

Second, the information on health effects should be disseminated to the user community. The Health Advisories provision in the bill would be an important vehicle in that regard. Due to the widespread potential use of such health advisories, ASHRAE strongly supports that such recommendations be subject to approval by an external panel of scientific experts composed primarily of private sector participants, including members of academic institutions.

ASHRAE interprets the term "advisories" to mean not regulations but guidelines that could be put into the private sector to establish control levels by promoting good design practices or, when appropriate, by developing consensus standards.

One option which may be discussed in the legislative deliberations is the issuance of technology and management practice assessment bulletins by the Administrator. Those could then be disseminated to the appropriate target populations. They need to be written differently depending on whether they are aimed at the general population or whether they are aimed at design professionals, and they need to be disseminated to that specific audience so

that general population information need not appear in trade journals or scientific meetings.

Information can flow directly from the public sector into these existing channels, or more efficiently and more reliably through the participation of government experts as members in the various technical and professional organizations, which would also benefit the government.

In situations where new guidelines or standards are then needed, one could shorten the time to implementation of those guidelines through participation and through the rapid reworking of consensus standards.

I would like to address two additional aspects of the indoor air legislation that were not addressed, really, in the bill. First, occupant health is not the only consideration when evaluating possible indoor air quality contaminants. The Standard 62 incorporates health information and control levels when available but generally is a comfort-based standard.

There are a lot of contaminants and conditions that lead to building-related complaints that are not regulated by Federal standards. There are comfort issues such as temperature, relative humidity and air flow that give rise to complaints that may be perceived as the sick building syndrome and may be indistinguishable.

In addition, a combination of low level contaminants may generate complaints that do not lead to a well-defined disease such as hyper-sensitivity, pneumonitis and allergic lung disease but lead to complaints of stuffiness or allergic rhinitis. Those would not necessarily be regulated or looked at as a major disease, and yet it is a major issue, not just for health but also for productivity.

Honeywell, Jim Woods, specifically, has done some studies looking at the prevalence of complaints in buildings in the United States, and it turns out that over 30 percent of the buildings in the United States do have complaints, and it is estimated that at least ten percent of the productivity of office workers is lost through inadequate control of workplace conditions.

Mr. SCHEUER. Are there any of these problems that affect productivity that do not affect health and would not be caught up with standards that are focused on health?

Dr. HODGSON. Yes.

Mr. SCHEUER. Describe them.

Dr. HODGSON. For example, thermal comfort. Temperature, relative humidity and air flow will make individuals feel tired or feel cold, not be able to concentrate well. Vibration transmitted from poorly anchored pumps will make VDTs bounce around and give people headaches but won't lead to chronic health effects. Glare on a VDT screen will get people to complain and not be able to concentrate, but it is not going to lead to chronic eye damage.

So there are both health issues in terms of defined diseases, and there are comfort issues that are very distinct.

ASRAE is not only concerned with the quality of the indoor environment but also in providing that environment in a cost-effective and energy conserving manner. Those are two important considerations in achieving acceptable environments. The technical developments for most of those are present. They have merely not been disseminated enough.

In summary, ASHRAE strongly supports this bill. We think that research should be a major focus. We believe that the health advisories portion is very important and could be extremely useful, and we think there does deserve to be consideration of health effects and comfort, and that this need not occur at the cost of energy costs.

[The prepared statement of Dr. Michael Hodgson follows:]

Committee on Science, Space and Technology
Subcommittee on Natural Resources, Agricultural Research
and Environment

U. S. House of Representatives

INDOOR AIR QUALITY HEARING

Testimony of
American Society of Heating, Refrigerating
and Air-Conditioning Engineers, Inc.

September 28, 1988



Mr. Chairman,

Thank you for the opportunity to be here today to comment on your proposed legislation on indoor air quality. I am speaking on behalf of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, which is commonly known by its acronym ASHRAE and is a technical society of some 50,000 individual members. Our membership is composed of consulting engineers, contractors, design professionals, and employees of academic and research institutions, manufacturers, and government.

ASHRAE's business is simply occupant comfort in buildings, all the technical knowledge associated with providing that comfort, and the effects of that technology on the environment. Indoor air quality is a major focus of Society activity and its Standard 62, "Ventilation for Acceptable Indoor Air Quality," is the only voluntary consensus standard available in the U.S. today to regulate the quality of the air indoors. I will provide more detail about ASHRAE and its related technical materials in my complete written statement, but now I would like to direct my comments to the legislation under consideration by the committee.

House Bill HR 3809 is a comprehensive bill directed at the broad indoor air quality problem. ASHRAE certainly supports such an effort. Let me emphasize two features of the bill and then add a few additional indoor air quality concerns for your consideration.

1. A major thrust of the bill is research. Government must take a leading role in research, particularly in the area of health effects and in the area of contaminant measurements. The private sector will not be able to accomplish all of the research needed in these two areas, but the private sector is able to disseminate and apply the results of such research.

ASHRAE, for example, has a research program which is supported by the private sector. A portion of its research dollars is directed at indoor air quality problems, but ASHRAE focuses more on buildings and building systems than on medical aspects.

2. It is important that information on health effects and recommended exposure levels be disseminated to the user community. The health advisories provision, Section 6 of the bill, will be an important vehicle in this regard. Due to the wide-spread potential use of health advisories, recommendations should be subject to approval by an external panel of scientific experts (composed primarily of private-sector participants). By using the term advisories, we interpret this, in most situations, to mean "guidelines" rather than regulations, which then could be put into the private sector to establish control levels by promoting good design practices or, when appropriate, by developing private-sector consensus standards. Sections 7c and d supports this activity.

One option which may be discussed in legislative deliberations is the issuance of technology and management practice assessment bulletins by the Administrator. It is important to identify the targeted audience of such bulletins - whether the target be the education of the general public or the transfer of technical data to the design professional or the sophisticated building owner/operator.

Any bulletins for the technical community should complement or make use of existing private-sector activities. Technical societies, trade associations, and the technical and trade press have efficient dissemination vehicles in place which may serve adequately. Within the professional community, ample opportunities for technical exchanges occur through forums, seminars, short courses, journals and periodicals where new technology can be introduced in a matter of months.

Information can flow from the public sector directly into these existing channels (representing a broad range of applicable specialties); a more efficient mechanism is the participation of expert governmental staff as individuals in the various applicable technical and professional organizations, providing a beneficial two-way flow of knowledge.

As an example of the incorporation of new technology by existing private-sector channels, ASHRAE has a four-volume handbook series which represents the world's most complete technical base related to building systems for the design professional. The volumes are regularly updated on a scheduled basis. New technology, when proven, can appear in the appropriate topical ASHRAE Handbook in as short a time period as one year and not more than four years. The information is then in the hands of the ultimate user or applicator.

In situations where new (or updated) guidelines or standards are needed, the private-sector's consensus standards process is adequate and networked into national, state and local code bodies when appropriate.

Now, I would like to address two additional aspects of the poor indoor air quality problem which you may wish to address in the proposed legislation. To make these points, I need to draw upon ASHRAE's experience in developing good design practices in the area of ventilation in buildings. The provisions of ASHRAE Standard 62-1981 are provided in the written comments, but our experience points out two important aspects which should be considered.

1. Occupant health is not the only consideration when evaluating possible indoor air quality contaminants. ASHRAE's Standard 62 incorporates health information and control levels when available, but generally the standard is considered to be what is termed a "comfort-based" standard; that is, a standard that covers contaminants and conditions in buildings which may not be a health risk but may affect indoor air quality. A combination of low-level concentrations of certain substances may not pose a health risk but may affect indoor air quality, resulting in annoyance and the perception of "sick building syndrome."

It is now generally accepted that discomfort in the work place significantly affects worker productivity and absenteeism. Studies have shown that buildings which do not have adequate temperature and humidity control may give the perception of "stuffy air" even when the air itself is relatively clean. Often, the problem has been associated with poor operation and maintenance practice. Buildings must be maintained and operated as designed to perform to desired levels.

2. ASHRAE is concerned not only with the quality of the indoor environment, but also in providing good indoor air quality in a cost-effective and energy-conserving manner. These are two very important considerations in achieving good indoor environments, and these two considerations may comprise many of the technological developments which will be needed. If cost is no consideration, any problem can be solved. If there always will be ample energy, then there is only economic need to conserve energy. ASHRAE's Standard 90 "Energy Conservation in New Building Design" is a resource document for energy codes and standards in all 50 states. ASHRAE is very concerned about the nation's future energy situation and urges energy conservation in all buildings.

Mr. Chairman, I refer you to the more detailed written statement, and I applaud your efforts on indoor air quality. In summary, ASHRAE would encourage the committee to consider more than just health effects in classifying contaminants and ask that the committee consider cost effectiveness and energy conservation when developing solutions to poor indoor air quality problems.

Thank you.

Mr. SCHEUER. Thank you very much. Dr. Hodgson.

This has been a most interesting panel and we are very grateful to you all.

Mr. McCabe mentioned the concept of unreasonable risk. I am going to ask the rest of you the same question that I asked the prior panel. The National Indoor Air Quality Response plan is intended to develop methods to reduce exposure to indoor air contaminants to levels at which there is—and again I quote that same phrase—no known or anticipated human health effects with an adequate margin of safety.

Again may I ask the rest of you: Is this a reasonable goal and how does it compare to the remedial action level EPA has published in the case of radon? Any of you? In other words, what should our goals be? How close to a risk-free society do we want to press to achieve, and at what expense, and in competition with other environmental goals and other non-environmental goals, education and health care in general?

Mr. WELCH. That kind of scheme, in my judgment, is going to depend upon the specific health effect of the air contaminant.

Mr. SCHEUER. Would you consider the comfort effects that Dr. Hodgson was talking about?

Mr. WELCH. He is the physician here and ought to speak to that question better than I, but let's use asbestos and radon as carcinogens which obviously are going to be a high level concern of this legislation. No known or anticipated health effects for carcinogens is, in effect, a zero exposure level. Telling the public that a level of zero is the only thing that is acceptable inside of a building when there are naturally occurring levels of asbestos or radon or formaldehyde or any of the other air contaminants doesn't illuminate or inform their decisionmaking.

It is like speed limits. People want a number that they can understand. They want to know if they are going too fast, if they are going too slow, and that is where the radon action level has at least better informed homeowners on making decisions on radon in their basements than the lack of an action level has informed building owners on making asbestos in buildings decisions.

So I think a far better concept, Mr. Chairman, to be more succinct is the use of meaningful benchmarks like negligible risk or unreasonable risk or things of that nature that the public is going to understand.

Mr. SCHEUER. We think the public may understand it, but when you talk about unreasonable or negligible, those are not susceptible, certainly, of legal interpretation. If they were set in an involuntary standard, a compulsory standard, they would lead to reams and miles of litigation as to the concept as to what is reasonable and what is negligible.

If we are talking about non-legal standards that people should just observe voluntarily, maybe that would be adequate.

Dr. HODGSON. If I might address that same question.

Mr. SCHEUER. Dr. Hodgson, please.

Dr. HODGSON. First of all, the definition of no risk is an oxymoron, according to the no-threshold, linear, one-hit model of carcinogenesis given the advancement in our ability to measure contaminants. For example, Professor Giam, formerly of Pittsburgh,

now of the University of Texas in, I believe, Galveston, has measured the concentration of trichloroethylene in the air over the South Pole. That is in the range of less than one part per trillion, but in fact, if you do high volume sampling, you can measure that.

On the basis of that regulatory model, you can calculate an albeit exceedingly small but a present risk. Therefore, the issue is not no risk but what risk are we willing to accept. Professor Ashford from MIT years ago put together a series of documents that were well known in the occupational and environmental health community called the trade-off documents, where he looked at the effects of regulating different pollutants and the relative effects of regulation to a specific level and the backstream effect on industries involved, the total cost involved to society, and the amount of diseases that are at each level of regulation prevented and caused.

For example, if you reduce SO₂ in the air through regulating coal, you have to get that back through other emissions. That means you may induce more oxides of nitrogen from other power plants and you may, therefore, get a shift of your societal costs.

So the issue is really making our societal choices transparent and not necessarily getting rid of risk. It is only by informing the public adequately of what the consequences of their choices are that we can actually have an informed public electing people we would like to have elected.

Mr. SCHEUER. I think that was a very thoughtful statement.

Mr. McCABE. Mr. Chairman, this is very similar to what the EPA did as it relates to radon. They did find something that is below the zero level, which is the four picos, and found that that was an acceptable risk when compared to other health risks in society. It also, I think, presented the public with some kind of a benchmark within which they could go and measure and feel somewhat comfortable.

I don't think this precludes further scientific study at a future date finding that that level is inadequate and at that time then perhaps additional steps have to be taken. OSHA has taken steps to determine levels of exposure to asbestos and has three times reduced that after further scientific study, so that there is no reason in the world that a study level that has been chosen at this point can't at a future date be changed with further scientific study.

I think the public has got to have something, some kind of a, if not called a standard, some kind of a benchmark within which they can measure whether they are safe. The asbestos issue has really been blown out of proportion with the general public because there is no safe level.

Mr. SCHEUER. If there is no safe level, then how can you say it has been blown out of proportion.

Mr. McCABE. I used that advisedly. I would not call it no safe level. I think the Federal EPA has determined that there is no safe level. I point out that in Colorado there has been recent asbestos legislation that has determined a particular level as being an acceptable action level, and it is a level within which building owners, occupants, lenders, purchasers can work within both economically and environmentally and feel safe. That doesn't, again, preclude the change in that determination.

Mr. SCHEUER. Are you speaking of feel safe in new buildings or are you speaking of rehabilitating and renovating existing buildings to take out the asbestos in this long period of nine or ten months that somebody spoke about where you actually increase the risk from what it was before in your effort to lower it?

Mr. McCABE. There is no question about it. The problem is that the exposure levels that have been determined by EPA have been extrapolated from very high exposure levels and brought down to low levels, and without making a determination that these low level exposures are safe or acceptable risk levels. So I guess I am talking about rehabbing existing buildings.

Mr. SCHEUER. And that is a dangerous business during the period of rehab.

Mr. McCABE. It is dangerous during the period of rehab for both occupants, for the worker long term. It is dangerous because of the improper transportation of the materials. There is such a rush today to remove this that you are ending up with disposal sites being exhausted. We are currently in New England moving our asbestos into disposal sites into Canada. Eventually, if we take all the asbestos out of these buildings, we will run out of disposal sites.

Then we are running into the further complication of the material we are putting in in place of asbestos, and I don't think anybody has really given much thought to that. EPA is currently giving a lot of thought to it. There was a recent work session that I attended that indicated that the rock wall is now being found to be a hazardous material, and that is exactly what has been used as a substitute, except more recently fiberglass has been used, and now fiberglass is becoming—

Mr. SCHEUER. Yes, that is also a hazardous material when the fibers are flying around.

Mr. McCABE. That is right. The problem is they haven't come to grips with an acceptable level that we can live with in the buildings and that results in removal and replacement with something else that is going to be worse than the cure. We are going to have a problem that we had with asbestos with these other materials that are being used as a replacement.

If EPA had chosen a level that was an acceptable risk level, we probably wouldn't be having the rush to removal that is being engendered by occupants, owners, lenders and prospective sellers.

Mr. SCHEUER. You are certainly stating that we have some considerable research goals ahead of us to accomplish to find out whether the current cures are worse than the problem. We certainly have to research how, if we are going to be continuing with renovation, how we protect workers. What kind of protection can we offer them during this process? We have to figure out answers to the question of disposal. Where can we dispose of these things, these toxic materials?

Then the question of whether during the process of renovation and rehabilitation, the buildings ought to remain occupied or whether they shouldn't be emptied of their usual occupants during this period. We have to find out whether the risk that they are subjected to during the 9, 10, 12 months of renovation is a serious enough risk for society to accept the cost of moving them out of that building entirely and relocating the activity somewhere else.

I don't know how you do that in the case of a school. I could see how it could be done in the case of an office. You could always rent temporarily office space, but in the case of a school, I don't know how you would relocate kids out of an entire building while the renovation was going on. Could you do it floor by floor?

In other words, if you are renovating on one floor, could the floors above and below be safe to carry on the education process?

Mr. McCABE. For the most part with schools we don't have that kind of a problem because it is done during the summer months when children are not in the school.

Mr. SCHEUER. I see.

Mr. McCABE. The more acute problem is in commercial buildings or public buildings where they are occupied on a 365-day a year period. The interesting irony is that when you have tested many of these buildings for levels of asbestos, even with damaged asbestos we find that the levels are higher in the ambient air outside of the building than they are inside the problem. It is a product of brake shoes, it's a product of asbestos being a natural material that happens to be in the air whether we like it or not.

Those levels, at least by Colorado and, I think, some other states have been found to be an acceptable risk level.

Mr. SCHEUER. I want to thank this panel for their most interesting testimony. I must leave now because I have another meeting, but I am going to turn the chair over to Ms. Schneider from Rhode Island and let her continue the questioning and then close the hearing in her discretion.

Thank you very much.

Mr. McCABE. Thank you, Mr. Chairman.

Dr. HODGSON. Thank you, Mr. Chairman.

Mr. WELCH. Thank you, Mr. Chairman.

Ms. SCHNEIDER. [Presiding.] Regrettably, I too have a meeting that begins at 1:00, despite the fact that I have about 52 questions I would like to ask this panel. I will say that the chairman has uncovered some very significant public health policy questions that certainly will be reflected in this legislation that we have been discussing. I am hopeful and will ask him that we hold additional hearings next year because I think there is an absence of some testimony.

Certainly the American Institute of Architects should be heard, and I think that you have raised some very valid considerations not only in terms of standards and policy but also in terms of research, which is critically important.

Businesses and public officials usually look to ASHRAE to set different standards for industry, especially when we are talking about ventilation technology or something of that sort. Once in ASHRAE standard is set, they often find their way into different building codes and into professional guidelines. Even though it is not a regulatory standard, they do, in essence, have the same effect.

So I am kind of curious if you could explain to me the difference of an ASHRAE standard and a government regulation. Is there a difference?

Dr. HODGSON. Yes, there is a major philosophical difference. ASHRAE is a professional organization that comes up with guide-

lines and recommendations through a consensus development process. The committees that exist that are ongoing that re-evaluate standards every five years have input from a variety of organizations. Commercial organizations with financial interests in the outcome play a major role. So they are interested in the outcome and they participate in the decisionmaking process.

Federal regulations are designed to be independent of those considerations, for very clear reasons, so they are philosophically quite distinct. One is set up as a regulation to prevent people from not doing what is there, and the other is to say, gee, this is what everybody else says we should really do. We are not going to say you are wrong if you come up with a better way, and it is not legally enforceable.

When it changes, when people come up with new ideas, it is much easier to change those consensus guidelines than it is, necessarily, to redo an OSHA regulation.

Ms. SCHNEIDER. This is true.

Dr. HODGSON. Benzene, for example, is now finally at the level that was proposed in 1980 or 1981, I believe.

Ms. SCHNEIDER. Do the panelists here feel that we have gotten enough information on the record in discussing the whole idea of outdoor concentration of pollutants as a benchmark for indoor concentrations? Mr. McCabe, you made some remarks a short while ago, but do all of you feel we have got enough on the record for now?

Dr. HODGSON. No, I don't.

Ms. SCHNEIDER. Feel free to contribute.

Dr. HODGSON. The implication of outdoor concentrations is generally looked at as a surrogate for occupational exposures, and indoor for environmental exposures. In fact, the problem is that when you talk about outdoor exposures, they are usually individual exposures. If you talk about exposures on a coke oven plant, you have benzene extractable fractions of polyaromatic hydrocarbons in the range of one to two to three parts per million. In the indoor air you may have similar exposures, but in fact most of them are reasonably innocuous.

So the issue of interaction of multiple low level exposure to pollutants and possible health outcomes is a much vaguer and probably less risky issue than well-defined exposures to higher pollutants. If you are going to talk about targeting exposures to prevent diseases, you get more effect by targeting high risk groups. So regulating, for example, radon progeny in underground mines is probably going to cure more lung cancers than trying to do away with all radon in the United States.

Ms. SCHNEIDER. Mr. Welch, did you want to make a comment?

Mr. WELCH. Certainly the main lesson that we have learned in dealing with the asbestos in buildings issue is the need to distinguish between occupational exposures and non-occupational or indoor exposures. I think that the health goal of working towards exposure levels that are close to outdoor air or significantly elevated above outdoor air is a worthy one. It is certainly unfair to the building owner to require that the air inside of his structure be cleaner than naturally-occurring contaminants outside of the structure.

Accordingly, I don't think that the doctor and I part ways, but I think we believe fairly strongly that moving towards an outdoor air level or significant elevations above outdoor level is a useful public policy goal.

Ms. SCHNEIDER. As I said, I think we are going to have to leave additional questions for a future date. I thank you all for elucidating this issue even further. I think we are collecting an unbelievable amount of data on this topic, and I think it is so important for us to make sure that we are focusing in the appropriate areas, that we are not creating a bureaucratic nightmare for implementation of these proposals. So I think the opportunities are well on our way to providing us solutions.

Thank you all very much.

Dr. HODGSON. Thank you, Ms. Schneider.

Mr. WELCH. Thank you.

Mr. McCABE. Thank you.

Ms. SCHNEIDER. Good-bye.

[Whereupon, at 12:58 p.m. the hearing was concluded.]

APPENDIX

Indoor Environment Program
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September 16, 1988

The Honorable James H. Scheuer
U.S. House of Representatives
2246 Rayburn Bldg.
Independence and S. Capitol St., S.W.
Washington, D.C. 20515

Dear Representative Scheuer:

Indoor air quality is becoming widely recognized as one of our most important environmental issues. Because of your work on one of the Congressional committees that deals with Federal research on indoor air quality, I am pleased to send you a copy of my recent article that appeared in May's *Scientific American* on "Controlling Indoor Air Pollution" (pages 42 to 47).

This article develops some of the principal concepts underlying any strategy to control the public's exposure to excessive pollutant concentrations indoors. These underlying concepts are often given insufficient thought by individual researchers, and even by government agencies, when confronted with the size of the exposures and associated health risks sometimes encountered in the indoor environment. I have tried to lay the key issues out, for example how we decide how much risk is too much in our homes, and how research on the behavior of indoor pollutants provides the basis for understanding the occurrence of high concentrations and for formulating sensible control strategies.

Radon is a good case in point. It is the indoor pollutant with which we can associate the highest estimated risk of cancer. These estimates are vastly higher than those that the Environmental Protection Agency is accustomed to dealing with. On the other hand, the average radon risk is considerably lower than the risks we accept from use of cars, and more or less equal to our risk from accidents in our homes, which -- because it is the same environmental setting -- seems an appropriate comparison. People accept risks of the order of one in a hundred in settings from which they derive direct benefit and over which they have control. It is in other settings or media -- specifically outdoor air and water supplies -- which industry or others may contaminate, that the public expects strict control to prevent this from occurring. In contrast, the indoor environment is a new setting in which to worry about pollutant risks, and we should avoid either discounting the risks because they are of a magnitude that people routinely accept, or overreacting to them because they are much larger than outdoor environmental risks. A new and appropriate perspective on risk and control needs to be developed for the indoor environment.

We need research to develop a fundamental understanding for interpreting what we see, locating what are genuinely excessive levels, and selecting proper approaches for control. Again, radon is an excellent example. Since the recognition by scientists in the late 1970's that this is our most serious radiation problem, the research community -- supported in large part by the Department of Energy and to a lesser extent by other agencies and entities -- established a basic understanding of the occurrence and behavior of indoor radon. Properly applied, this enables us to interpret new results, including the data developed since 1985 with the wider recognition of the importance of indoor radon and due to the associated activity of the EPA.

It was in light of this understanding of radon behavior that, for example, members of the research community pointed out to EPA staff last year that their press material incorrectly gave the impression that 20% of the homes surveyed in ten states had elevated radon concentrations compared with the EPA guideline for remedial action. Unfortunately, the same misrepresentation occurred this past week during EPA's press conference on the more recent seven-state survey. An even larger fraction of houses was said to have elevated concentrations, which is not true if the EPA guideline (which is for average concentrations in the *living* space, not short-term concentrations in, for example, basements) is used as the benchmark. Unfortunately almost all of the press reports missed this lapse, and I am sure that the same was true of the public. But scientists in the field know about the dependence of concentration on location in the house and about the variability with time, and therefore realize that measurements taken with the EPA monitoring protocol have to be modified substantially to yield a result that is indicative of people's exposures and therefore of whether the house has "elevated" levels. (I have communicated concern about this issue to the EPA, along with suggestions on how a more effective interaction between the EPA and the research community at large might be accomplished, especially in developing materials for the public.)

Perhaps the most important point is the growing need for support of Federal research on indoor air quality. This includes the EPA, which has the prime responsibility for implementing remedial programs, agencies such as the Department of Energy and the Consumer Product Safety Commission -- which have responsibilities for research on buildings and their contents, as well as on the influence of their design and operation on indoor exposures -- and the National Institutes of Health, the leader of basic health research. Some of the agency capabilities and contributions are not obvious from their generalized responsibilities. For example, the Department of Energy -- which established the program of indoor air quality research at Lawrence Berkeley Laboratory more than a decade ago -- has done pioneering research on the dependence of indoor concentrations on ventilation rates and other building-related factors, on the chemistry and physics of the indoor atmosphere, and on the health effects of radon.

In addition to support for action programs (where appropriate), on the one hand, and basic research, on the other, I believe that more attention needs to be given to the development of explicit assessment tools. These would represent our scientific knowledge in a systematic way as a basis for estimating the exposures and health risks occurring in the actual housing stock (and not just in an idealized house) or for converting a short-term

radon test result to a long-term estimate for use in real-estate transactions (or in interpretation of survey results). Such tools have immediate application.

Given the importance of indoor radon, I would also suggest that the EPA be charged with a systematic re-examination of its public materials on radon and of its associated monitoring protocol and remedial action guideline. The public materials should state more carefully what we know about radon, its occurrence, and health effects. Considering recent experience, it is necessary to associate with the monitoring protocol a better way of interpreting the results. As to the recommended action level, I do not mean to suggest necessarily that it be changed. But, considering that some people believe it is too strict, while others believe that we should try to lower concentrations to outdoor levels, the community needs to examine the premises and expectations for control of health risks in the indoor environment, along the lines indicated at the beginning of this letter. So, rather than telling the EPA to change its objectives one way or the other, I suggest that -- in conjunction with other agencies and the scientific community -- the EPA be charged with performing a more complete and more systematically reviewed analysis of radon guidelines, protocols, and information for the public.

These remarks are of course my own views and not necessarily those of Lawrence Berkeley Laboratory, the Department of Energy, or the other agencies supporting our work. However, indoor air quality is important to all of us, and I think it important to discuss the associated, sometimes complicated, issues. In this vein, I hope that you find the enclosed *Scientific American* article interesting. Should you or your staff have any comments, my colleagues and I at Lawrence Berkeley Laboratory would be pleased to hear them.

Sincerely,

Anthony V. Nero, Jr.

Anthony V. Nero, Jr.
Senior Scientist
Indoor Environment Program

Enclosure
AVN/tg

Testimony of Anthony V. Nero, Jr.
Senior Scientist, Indoor Environment Program
Lawrence Berkeley Laboratory

Submitted to the
House Science, Space and Technology Committee
Subcommittee on National Resources, Agriculture Research and the Environment

September 28, 1988

Mr. Chairman and Members of the Subcommittee:

Indoor air quality is becoming widely recognized as one of our most important environmental issues. Because of its importance, it is appropriate that the responsible Federal agencies support research on indoor air quality and that -- based on this research -- appropriate action be taken, where necessary, to reduce excessive concentrations of indoor pollutants. I am pleased to be able to comment on this important matter as this Subcommittee considers legislation that will charge the Environmental Protection Agency, together with other Federal Agencies, with a more concerted effort on indoor air quality.

There has already been substantial research on the occurrence and health effects of indoor air pollutants. It is this work, carried out either in explicit research on indoor air quality or in the course of programs on other topics related to indoor exposures, that has provided the basis for the growing awareness of the importance of indoor pollutants. The work that applies specifically to indoor air quality has been carried out primarily by the Department of Energy, the Environmental Protection Agency, and the Consumer Product Safety Commission. Each has a significantly different responsibility and capability in regard to indoor exposures. More general work, especially concerning health effects, has been conducted by other agencies, such as the National Institutes of Health.

Substantial research efforts for understanding the relationship between ventilation and indoor air quality were begun by DOE during 1975 to 1977, primarily because of the concern that increasing building energy efficiency might, by reducing ventilation rates, increase the public's exposures to air pollutants emitted directly into the indoor environment. An early result of DOE work is that -- for any given pollutant -- indoor concentrations have a very wide range, only partially caused by differences in ventilation rates, and that moderate changes in ventilation rates associated with energy conservation would alter indoor concentrations by an amount very small by comparison with the normal variation in concentration from one building to another. This variability arises because of differences in emission rates from the sources of each indoor pollutant. In other words, the 20 or 30% decrease in ventilation rate that might arise from an effective program to reduce infiltration rates in houses would not raise a normal pollutant concentration to an unacceptable level. Other factors are the key determinant of whether or not a building has excessive pollutant levels. (An exception could be a building employing highly specialized measures to reduce infiltration rates far below the norm. Such a building would have to employ appropriate

indoor-air-quality control measures to avoid excessive indoor levels.) This observation by no means removes the rationale behind DOE research on indoor air quality. Indoor levels are still determined by a complex mix of influences directly affected by building design and operational features, many of which are energy related and under active investigation by DOE. A primary example is that the same environmental factors -- temperature differences and winds -- that cause infiltration through the building's above-ground structure also cause the small pressure differences between the soil and the building interior that draw radon-bearing air from the soil into the indoor atmosphere. DOE research efforts have led to an understanding of the scientific principles and the practical implications -- in terms of finding and fixing high-radon houses -- associated with this basic picture of radon entry. The attached excerpt from a recent book on radon indicates how a basic appreciation of radon and decay-product behavior, based on research of how indoor air is affected by the interaction between the building and the external environment, has provided a framework for understanding future surveys or basic research on the behavior of indoor atmospheres. (Anthony V. Nero, Jr.: pp. 8-27 of "Radon and its Decay Products in Indoor Air: An Overview" in W.W. Nazaroff and A.V. Nero (Eds.), *Radon and Its Decay Products in Indoor Air*.) In a similar way, basic research on other indoor pollutants by DOE and others has led to an understanding of their occurrence and behavior, providing an appreciation of exposures (and health risks) and a basis for understanding issues of control.

A recent *Scientific American* article on "Controlling Indoor Air Pollution" is included with this testimony because it explores our current understanding of pollutant behavior and health risks and the development of control strategies (Anthony V. Nero, Jr.: Controlling Indoor Air Pollution, *Scientific American*, Vol. 258 (No. 5), pp. 42-28, May 1988). This article develops some of the principal concepts underlying any strategy to control the public's exposure to excessive indoor pollutant concentrations. These concepts are often given insufficient thought by individual researchers, and even by government agencies, when confronted with the level of the exposures and associated health risks sometimes encountered in the indoor environment. Radon is a good case. It is the indoor pollutant with the highest estimated risk of cancer. These estimates are vastly higher than those that the Environmental Protection Agency is accustomed to dealing with. On the other hand, the average radon risk is considerably lower than risks we accept by using cars, and more or less equal to the risk of accidents in homes, which -- because it is the same environmental setting -- seems an appropriate comparison. People accept lifetime risks of the order of one in a hundred in

settings from which they derive direct benefit and over which they have control. It is in other settings or media -- specifically outdoor air and water supplies -- which others may contaminate, that the public expects strict control to prevent even very small risks from occurring. In contrast, the indoor environment is a new setting in which to worry about pollutant risks. We should avoid either discounting these risks because they are of a level that people routinely accept, or overreacting because they are much larger than outdoor environmental risks. A new and appropriate perspective on risk and control needs to be developed for the indoor environment.

We need research to develop a fundamental understanding for interpreting results, locating genuinely excessive levels, and selecting proper control approaches. Again, radon is an excellent example. Since the recognition by scientists in the late 1970's that this is our most serious radiation problem, the research community -- supported in large part by the Department of Energy -- established a basic understanding of the occurrence and behavior of indoor radon. Properly applied, this enables us to interpret new results, including the data developed since 1985, with the wider recognition of the importance of indoor radon.

It was with this understanding of radon behavior that members of the research community informed EPA staff last year that their press material incorrectly gave the impression that 20% of the homes surveyed in ten states had elevated radon concentrations compared with the EPA guideline for remedial action. Unfortunately, the same difficulty occurred in recent weeks during EPA's press conference on the more recent seven-state survey. An even larger fraction of houses was said to have elevated concentrations, which is not true if the EPA guideline (which is for *average* concentrations in the *living* space, not short-term concentrations in, for example, basements) is used as the benchmark. Unfortunately almost all of the press reports missed this important qualifier. But scientists in the field know about the dependence of concentration on location in the house and about the variability with time, and realize that measurements taken with the EPA monitoring protocol have to be modified substantially to yield a result that is indicative of actual exposures and whether the house has "elevated" levels. This shows the need for a growing understanding of pollutant behavior to be used in interpreting data as a basis for action, either by governmental entities, contractors, or members of the public.

The most important need today, moreover, is for increased support of Federal research on indoor air quality. This includes the EPA, which has the prime responsibility for implementing remedial programs, agencies such as the Department of Energy and the Consumer Product Safety Commission -- which have responsibilities for research on buildings and their contents, as well as on the influence of their design and operation on indoor exposures -- and the National Institutes of Health, the leader in basic health research. Some of the agency capabilities and contributions are not obvious from their generally-known responsibilities. For example, the Department of Energy -- which established the indoor air quality research program at Lawrence Berkeley Laboratory more than a decade ago -- has done pioneering research on the dependence of indoor concentrations on ventilation rates and other building-related factors, on the chemistry and physics of the indoor atmosphere, and on the health effects of radon.

In addition to support, remedial programs (where appropriate), on the one hand, and basic research, on the other, more attention needs to be given to the development of explicit assessment tools. These would represent our scientific knowledge in a systematic way for estimating the exposures and health risks occurring in the actual housing stock (and not just in an idealized house) or for converting a short-term radon test result to a long-term estimate for use in real-estate transactions (or in interpretation of survey results). Such tools have immediate application.

Indoor air induces our most significant exposure to many classes of pollutants. We must increase our understanding of the behavior and health effects of indoor pollutants, as well as formulate strategies for controlling excessive levels. An important bridge between understanding and strategies is the development of assessment tools and of a perspective on indoor risks. I hope that you will find the enclosed *Scientific American* article interesting in connection with the latter. We wish to thank you again for the opportunity to provide information on this important topic. Should you or your staff desire any more information, my colleagues and I would be pleased to provide it.

Note: This testimony represents the sole view of its author and not the Lawrence Berkeley Laboratory or the University of California.

2.2 Factors Affecting Indoor Concentrations

The indoor concentration of radon and its decay products, or of any other airborne pollutant, depends on three factors: the entry or production rate from various sources, the ventilation rate, and the rates of chemical or physical transformation or removal. Because of its relatively long half-life and lack of chemical activity, ^{222}Rn itself acts much like a stable pollutant whose indoor concentration is determined by only two factors, the entry rate and the ventilation rate. In contrast, the behavior of the decay products is much more complex, depending on the radon that is present, the ventilation rate, and the interplay among radioactive decay, chemical reactivity, particle concentrations, and the nature of the boundary layer between the indoor atmosphere and the surfaces that enclose it. Nonetheless, as a practical matter, the decay-product concentration is indicated approximately by the radon concentration, which is determined by source and ventilation characteristics. The influence of these factors on indoor concentrations is discussed here briefly. In addition, Section 8.2 treats the question of ventilation rates per se.

Both excessive entry rates and decreased ventilation rates appear to be important causes of the high concentrations found in Swedish homes, which constituted a signal that scientists in other countries should investigate radon concentrations in their own building stocks. It is important to realize that extensive research on other aspects of indoor air quality was also beginning about the same time (see citations in Table 1.1), because of the discovery that several classes of pollution could occur indoors at higher levels than outdoors. For example, the by-products of combustion—such as carbon monoxide, nitrogen oxides, and particulates—are primary pollutants from the point of view of outdoor air quality. But concentrations are often much higher indoors, owing to the presence of gas stoves, kerosene space heaters, and other appliances that are not vented effectively to the outdoors (1, 2). Similarly, although organic chemicals of various kinds are regulated in outdoor air and around toxic waste dumps, concentrations can be much higher indoors, again because of the presence of indoor sources (3, 4). In the United States, much of the research on indoor air quality began because of the fear that energy-conservation measures might raise levels of such pollutants.

The basis of this concern may be seen by considering the steady-state concentration of a nonreactive gas entering an interior space from effectively internal sources (including the ground) at a fixed rate per unit volume, S_v . The concentration in this case is easily shown to be

$$I = (S_v + I_o \lambda_v) / (\lambda_v + d) \quad (1)$$

where λ_v is the ventilation rate, I_o is the concentration in outdoor air, and d is the decay rate of the gas (if applicable). For typical ventilation rates, greater than 0.1 h^{-1} , the decay rate of ^{222}Rn (0.0076 h^{-1}) can be ignored in this equation, so that $I - I_o = S_v / \lambda_v$. This simplifies even further, to $I = S_v / \lambda_v$, when—as is often the case—the outdoor concentration is much smaller than the indoor.

This expression does not encompass recently understood and important aspects of radon behavior, including time-dependent and interactive phenomena, as discussed in later sections. Moreover, as is obvious, it cannot be used to describe the behavior of radon decay products, whose concentrations are determined by a number of interdependent reaction rates, as described qualitatively below and in more detail in succeeding chapters. Nonetheless, it is useful for specific analytical purposes, an obvious example being that, for a fixed source strength, a decrease in the ventilation rate—e.g., to save energy—will result in a corresponding increase in the indoor concentration.

However, the relative importance of source strengths in determining indoor radon concentrations became clear in initial studies of concentrations and ventilation rates in U.S. homes. Earlier work had already indicated significant concentrations of ^{222}Rn and its decay products in U.S. homes (5), and subsequent work had confirmed that, with supply of differing amounts of mechanical ventilation in a given house, the radon concentration varied as the inverse of the ventilation rate (6). But results from simultaneous ^{222}Rn and ventilation-rate measurements in several groups of homes showed no apparent correlation between these two parameters (7). As shown in Figure 1.3, the radon concentrations and ventilation rates for each sample group showed an approximately order-of-magnitude range; for the combined sample of about 100 homes, the concentration showed a significantly larger variability than the ventilation rate. If the ventilation rate λ_v and source strength S_v were independent in this sample of houses, and if the range of concentrations observed were caused primarily by differences in ventilation rate, then—because $I = S_v / \lambda_v$ takes a linear form $\ln I = \ln S_v - \ln \lambda_v$, on a logarithmic plot—the data points of Figure 1.3 would cluster around a straight line with slope -1 . No such correlation is apparent. The relative range and independence of these two quantities suggested that the source strength was the dominant determinant of the wide range of concentrations observed in U.S. housing.

Such indications have prompted substantial work in understanding the size and variability of radon entry rates, as discussed below. However, it is important to emphasize that other factors still play an important role: ventilation rates vary substantially within the housing stock, which is, of course, one of the major incentives for past and current efforts to increase the efficiency of energy use in buildings. (In the United States, an added incentive is that even the average ventilation rate—see Section 8.2—is relatively high compared with rates in many countries.) And, even for a given radon concentration, the concentrations and physical state of the decay products—which account for the health effects of principal concern—can vary significantly. We turn now to a brief review of indoor

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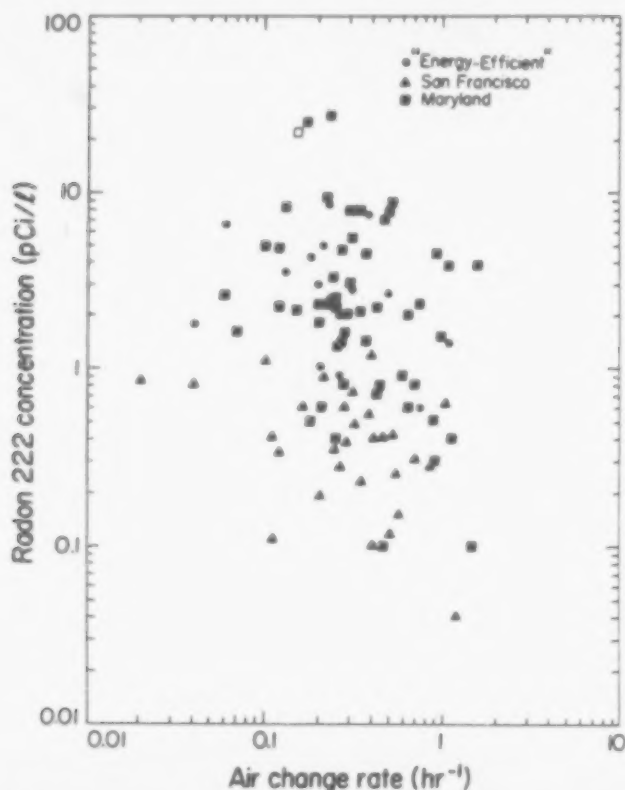


Figure 1.3. ^{222}Rn concentrations and air exchange rates measured in 98 U.S. residences. The results shown are from three survey groups: "energy-efficient" houses in the United States and (one) in Canada; conventional houses in the San Francisco area; and conventional houses in a community in rural Maryland. Data from Ref. 7.

^{222}Rn concentrations, after which we shall examine more closely the factors affecting indoor levels. Concentrations of ^{220}Rn and its decay products are treated in Section 8.4.

3 INDOOR CONCENTRATIONS

Since identification of ^{222}Rn and its decay products as potentially important indoor pollutants, a large number of efforts have been undertaken actually measuring concentrations in homes. In a few countries, mostly European, these efforts have even included surveys in statistically designed samples of the housing stock. Taken together, monitoring efforts to date provide a useful appreciation of residential radon concentrations in—not only Europe—but even the United States, where a wide variety of small or local survey efforts have been completed. Data are less complete for commercial and public buildings, although a variety of information

can be brought to bear to suggest the approximate scale of radon concentrations in such environments.

This section briefly reviews the results of indoor radon surveys, primarily those performed in residences. No attempt is made to mention the many specific studies that have been performed. In particular, for residences—the focus of large numbers of efforts—only the few surveys or analyses that are representative of a large segment of the housing stock are discussed explicitly. Results from a significant number of individual surveys may be found in the major references given in Table 1.1 and in numerous individual journal articles and reports. Most of the results discussed here are summarized in Table 1.2.

It is also worth noting the tendency of the research community to measure radon concentrations in survey efforts, rather than decay-product concentrations. This tendency arises largely from the availability of reasonably reliable and very simple integrating etched-track radon monitors (see, for example, Ref. 8), a significant contrast to the state of decay-product monitoring. (An alternative technique being used in many shorter-term studies is based on collection of radon for a few days in charcoal cannisters; see, for example, Ref. 9.) Fortunately, given a reasonable understanding of the relationship between radon and its decay products and an awareness of the fact that the decay-product-to-radon ratio (typically in the range of 0.2–0.8) does not vary as widely as radon concentrations, measurement of radon is a reasonable indicator of decay-product concentrations and is a very effective tool in survey efforts. This is analogous to the situation for many other pollutants: for example, although health effects associated with NO_2 exposures may have a substantial dependence on peak (rather than average) concentrations, an integrating sampler can be a very effective survey instrument, provided that associated studies examine relationships between average and peak concentrations under well-characterized conditions. As seen below, another incentive for emphasizing the radon concentrations per se is that this parameter appears to be a relatively direct indicator for use in strategies for identifying and controlling excessive concentrations, and, as discussed in Chapter 7, it may actually be a more consistent indicator of dose than the decay-product concentration.

3.1 Concentrations in North American Housing

Despite a broad range of U.S. efforts to characterize indoor radon, including a substantial number of studies that have included measurements in existing U.S. homes, there has been no direct broad-scale determination of the concentrations to which the U.S. population is exposed. The numerous U.S. studies have varied significantly in incentives, scientific objectives, selection of homes, and measurement procedures. The results from these studies therefore vary significantly, as do the conclusions that may be drawn from them. An obvious solution to this difficulty would be to carry out measurements in a valid statistical sampling of U.S. homes. From even an approximate evaluation of the data already in hand, it is clear that measurements in on the order of 1000 homes would determine the mean concen-

TABLE 1.2 Distribution of ^{222}Rn Concentrations in Various Countries

Country	No. of homes monitored	Type	Concentration (Bq/m^3)		GSD or % of tail	Notes	Ref.
			GM	AM			
U.S.	817	Single-family	33	55	2.8	Aggregated 22 data sets, adjusting to annual-avg.	10
Canada	453		38	54	2.36	Physics professors	11
	9999		13		2.7	Median values from 14 city surveys; mostly basement values; PAEC converted assuming equil. factor = 0.5.	14
Sweden	500	{ Detached Apartments	69	122	2% > 800 Bq/m^3	Built before 1975	15
Denmark	22	{ Single-family Flats	53	85	0.5% > 800 Bq/m^3	Preliminary surveys; average of winter and summer means	18
Finland	2000	Small houses	64	82			17
F.R.G.	6000		40	49	2% > 800 Bq/m^3		20
Netherlands	1000		24		1.8		22
Belgium	79		41		1.6	High levels show excess above lognormal	79
France	765		44	76	1.7	Preliminary national survey	80
U.K.	2000		15	25	2% > 200 Bq/m^3	Incomplete natl. survey	21
Ireland	250		43		2.6	Living areas; bedrooms had GM of 11 Bq/m^3	81
Japan	251		19		10% > 100 Bq/m^3	Preliminary survey	82
					2% > 100 Bq/m^3	Composite of 4 city surveys	

GM = geometric mean

GSD = geometric standard deviation

AM = arithmetic mean

tration very accurately and ascertain the fraction of homes at high concentrations (say, 10 times the mean) to a reasonable accuracy.

However, regardless of such an effort, the data already available are quite substantial, including tens of data sets from a wide variety of studies, with the precise number depending on the criteria for inclusion. It has been clear for some time that a systematic analysis of available data would have considerable value, and such an analysis has been performed on data available as of 1984–1985 (10). This analysis explicitly considered important differences between the studies and aggregated the various data sets, using both nonparametric and lognormal representations to yield a nominal radon distribution for single-family houses (the dominant type of residence) in the United States. Figure 1.1 shows the probability distribution obtained from direct aggregation of 19 of the data sets for which individual data were available. This particular aggregation, although not suitable for drawing conclusions about annual-average concentrations, indicates the substantial conformance of indoor radon concentrations to a lognormal representation, a result that has been observed in many individual studies.

The analysis examined a total of 38 data sets, corresponding to different areas (usually a state or urban area) of the United States. A significant number of these sets arose from monitoring effects that were prompted by some prior knowledge of a potential for elevated concentrations. However, the main conclusions of the analysis were based on 22 data sets apparently lacking such prior indication. In either case (i.e., the 38 sets or the 22-set grouping), the geometric mean (GM) concentrations from the sets ranged from 11 to 210 Bq/m³ (actually, 0.3–5.7 pCi/L, since *all* of these studies used the traditional units). Geometric standard deviations (GSDs) ranged from 1.3 to 4 among all 38 sets.

The results of aggregating these sets in different manners are quite robust, with the main distinction being simply that aggregations utilizing the full 38 sets yielded a somewhat higher aggregate mean than those including only the 22 “unbiased” sets. The overall result, relying on the 22-set aggregations (and including a normalization of data taken only during heating seasons to obtain an estimate of year-long averages) is a distribution of annual-average ²²²Rn concentrations that averages 55 Bq/m³ (1.5 pCi/L) and that has a long tail with 1–3% of homes exceeding 300 Bq/m³ (8 pCi/L). The analysis indicates that 7% (or about 4 million) of the U.S. single-family housing stock have concentrations greater than 150 Bq/m³ (4 pCi/L). Alternatively, the distribution can be expressed as a lognormal function with a GM of 33 Bq/m³ (0.9 pCi/L) and a GSD of 2.8. This result can only be associated with the portion of the housing stock consisting of single-family houses, since 99% of the data are drawn from such homes. However, this is the dominant element of the U.S. housing stock, and the results indicate that on the order of a million homes in the United States have annual-average ²²²Rn concentrations of 300 Bq/m³ or more. (Another interesting observation from this analysis is that the geometric means of the “unbiased” 22 sets are themselves lognormally distributed, with a GSD of 2.0. This index demonstrates the substantial variability of mean indoor radon concentrations from one area to another.)

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Currently, results from studies involving larger numbers of homes, often selected on a statistical basis or covering a larger portion of the United States, are beginning to become available. A notable example is a study that performed integrated year-long measurements in the homes of approximately 450 physics faculty at about 100 colleges and universities across the United States (11). The ^{222}Rn concentrations so obtained average 54 Bq/m^3 (1.47 pCi/L) and fit a lognormal distribution admirably well, with a GM and GSD of 38 Bq/m^3 and 2.36, respectively. This implies that 0.8% of homes have concentrations greater than 300 Bq/m^3 , at the low end of the range estimated from the analysis discussed above. On the other hand, the fraction above 150 Bq/m^3 , 6%, is very close to the earlier result. Although a study of homes of physics faculty cannot be construed to be a representative sampling of U.S. homes (a problem suffered also by the aggregate analysis just discussed), this study has the advantage that the homes are widely distributed across the United States and that the measurement protocol determined directly a year-long average concentration. The averages from the 100 or so institutions are themselves lognormally distributed, with a GM of 46 Bq/m^3 and a GSD of 1.75. Interestingly, the highest average from both this study and the aggregate analysis above occurred in the state of North Dakota.

This suggests the need to recognize that the broad distributions discussed here do not of themselves reveal the much higher distributions that may occur in specific areas. For example, both studies just referred to indicate that areas of North Dakota have average concentrations much higher than the U.S. mean, and a correspondingly higher portion of houses exceeding any particular concentration. More recently, two other such areas have been identified, one in the Spokane River Valley of Washington and Idaho, where the average winter concentration in 46 homes was found to be 500 Bq/m^3 (13.3 pCi/L), with 20 of the houses exceeding 300 Bq/m^3 (12). At about the same time, astounding concentrations were found in eastern Pennsylvania (a state that was already known to have very high levels in some locales) (13). Although no dependable frequency distribution can be extracted from the results of monitoring about 4000 homes in this area, the average appears to be similar to the Spokane results, but with a much larger number of houses involved and with indoor radon concentrations as high as $100,000 \text{ Bq/m}^3$. An exceptional concentration of high levels has also been found in the town of Clinton, New Jersey, where about half of approximately 100 houses monitored in one neighborhood had winter concentrations exceeding 7500 Bq/m^3 .

A significant number of the earlier studies analyzed in Ref. 10 measured the concentration of decay products instead of radon. One of these in particular (5) measured both concentrations averaged over week-long periods, thereby determining directly an effective equilibrium ratio, which was found to range from 0.31 to 0.82 among the houses examined. As is evident from the measurements from other countries, discussed below, there is significant evidence that equilibrium ratios tend to average about 0.4 among samples of housing, with significant variability from one time to another, from one house to another, and perhaps some differences from one region or country to another.

One of the earliest large studies was conducted in Canada, where an approximate idea of indoor concentrations has been obtained by performing grab-sample measurements in a large number of homes (9999) across that country (14). Rather than being a representative sampling, homes were selected from 14 of Canada's largest cities, therefore directly representing a major portion of the housing stock. The geometric mean EEDC varied from 3 to 13 Bq/m³ among these cities, the median being 7 Bq/m³. The median GSD was about 2.7. These results cannot, however, be thought of as representing the living-space average of these homes, since the preferred sampling site was chosen to be the basement. (The ²²²Rn concentrations were also measured, but are suspect in view of the very large GSD obtained, a median of 4.0 among the 14 cities, and the fact that measurements were performed in basements.)

3.2 Residential Concentrations in Europe

Significant efforts to determine indoor radon concentrations have been conducted in numerous European countries. However, in only a few have these efforts been designed to provide representative information on concentrations in the housing stock as a whole. The results from studies designed, more or less, to meet this objective, differ to a significant, but understandable, degree from one country to another.

Sweden, a principal in inciting the wide interest in radon, has more recently completed a country-wide survey, utilizing 2-week passive ²²²Rn measurements in about 500 homes built before 1975 (15). The results averaged 122 Bq/m³ (GM 69 Bq/m³) for 315 detached houses and 85 Bq/m³ (GM 53 Bq/m³) for 191 apartments. The distributions are approximately lognormal, with 10% of the results over 266 Bq/m³ (detached) or 187 Bq/m³ (apartments). Overall, concentrations are higher than for countries outside Scandinavia, with about 2% of detached homes and 0.5% of apartments estimated to have ²²²Rn concentrations exceeding 800 Bq/m³—comparable to their remedial action level of 400 Bq/m³ EEDC, assuming a typical equilibrium factor of 0.5. A supplementary study of detached houses built since 1975 yielded a GM similar to that for the larger study, but with a smaller fraction at high concentrations (16).

Preliminary results from measurements in more than 2000 houses in Finland yield a GM of 64 Bq/m³ and about 2% greater than 800 Bq/m³, similar to the Swedish single-family results (17); a strong geographical dependence was observed. Results from a small sampling in Denmark show somewhat lower concentrations in that country, e.g., average (not GM) concentrations in single-family dwellings of 88 Bq/m³ in winter and 24 Bq/m³ in summer (18). However, some of the apparent difference may arise from differences in measurement period.

Results from a survey of about 6000 homes in the Federal Republic of Germany using etched-track ²²²Rn detectors have recently become available, yielding a GM of 40 Bq/m³ and GSD of 1.8 (19). In spite of the fact that a larger number appeared at high concentrations than indicated by these lognormal parameters, only

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10 (0.2%) of the homes sampled had concentrations exceeding 500 Bq/m^3 . Other results from the FRG indicate an equilibrium factor of 0.3 indoors and 0.4 outdoors (20).

A survey mounted in the United Kingdom has measured ^{222}Rn concentrations in about 2000 homes, yielding a GM of 15 Bq/m^3 and GSD of 2.6 for living areas (11 Bq/m^3 and 2.5 for bedrooms). The ratio of summer to winter concentrations was found to be 0.51 in living areas and 0.53 in bedrooms. Concentrations substantially higher than these overall values have been found in specific areas, such as Cornwall (21).

Measurement of ^{222}Rn concentrations in about 1000 dwellings in the Netherlands gave a distribution well represented (except for an excess of high concentrations) by a lognormal function with GM 24 Bq/m^3 and GSD 1.6 (22).

In Europe, it is also important to realize that many of the countries mentioned have identified areas or portions of the housing stock with exceptionally high concentrations. As noted earlier, it was housing with concretes using alum-shale as aggregate that drew initial attention to indoor radon as a problem, but more recently radon from the ground has been identified as the primary source in Swedish housing, and this varies substantially from one area to another. In Finland, a study on the south coast found averages in the 31 locales surveyed to range from 95 to 1200 Bq/m^3 , with the total sample averaging 370 Bq/m^3 and 12% of houses exceeding 800 Bq/m^3 (23). As a final example, the average from Cornwall was 390 Bq/m^3 , 15 times the national average for the United Kingdom (21).

More limited information is available from a number of other countries. Except for special local areas, none of the results exceed the distribution found for the Scandinavian countries. And some approach the considerably lower levels characteristic of the outdoors, with average concentrations in the vicinity of 10 Bq/m^3 .

3.3 Other Buildings

Very few data are available on radon concentrations in buildings other than residences. However, the same range of radon sources contributing to residential radon also contribute—to a greater or lesser degree—to levels in other buildings. Hence, it is to be expected that the minimum concentration observed in such buildings is the outdoor level—averaging about 10 Bq/m^3 of ^{222}Rn , as indicated in Section 8.3—but that higher levels, even in the range of those in residences, should be the norm. To the extent that structures such as hospitals or office buildings have a larger number of stories and higher ventilation rates than residences, we would expect lower concentrations.

Only a small number of measurements in other buildings—whether offices, stores, hospitals, or schools—have actually been performed, and virtually no statistically meaningful data have been developed. It is, nonetheless, worth mentioning two substantial studies from the United States as examples. One of these was conducted in the Pittsburgh, Pennsylvania, area, using grab-sample measurements taken during occupancy (an important issue if ventilation systems are turned off during unoccupied hours) in schools, stores, and other public and commercial

buildings (24). Average concentrations for various groups of buildings, many including on the order of 100 measurements, were in the vicinity of $15\text{--}20\text{ Bq/m}^3$, slightly higher than the outdoor concentrations measured (about 10 Bq/m^3), and much less than the annual-average concentrations found in a local survey of residential levels, about 96 Bq/m^3 . A survey of 38 office buildings in the Pacific Northwestern United States found concentrations to average 11, 26, and 44 Bq/m^3

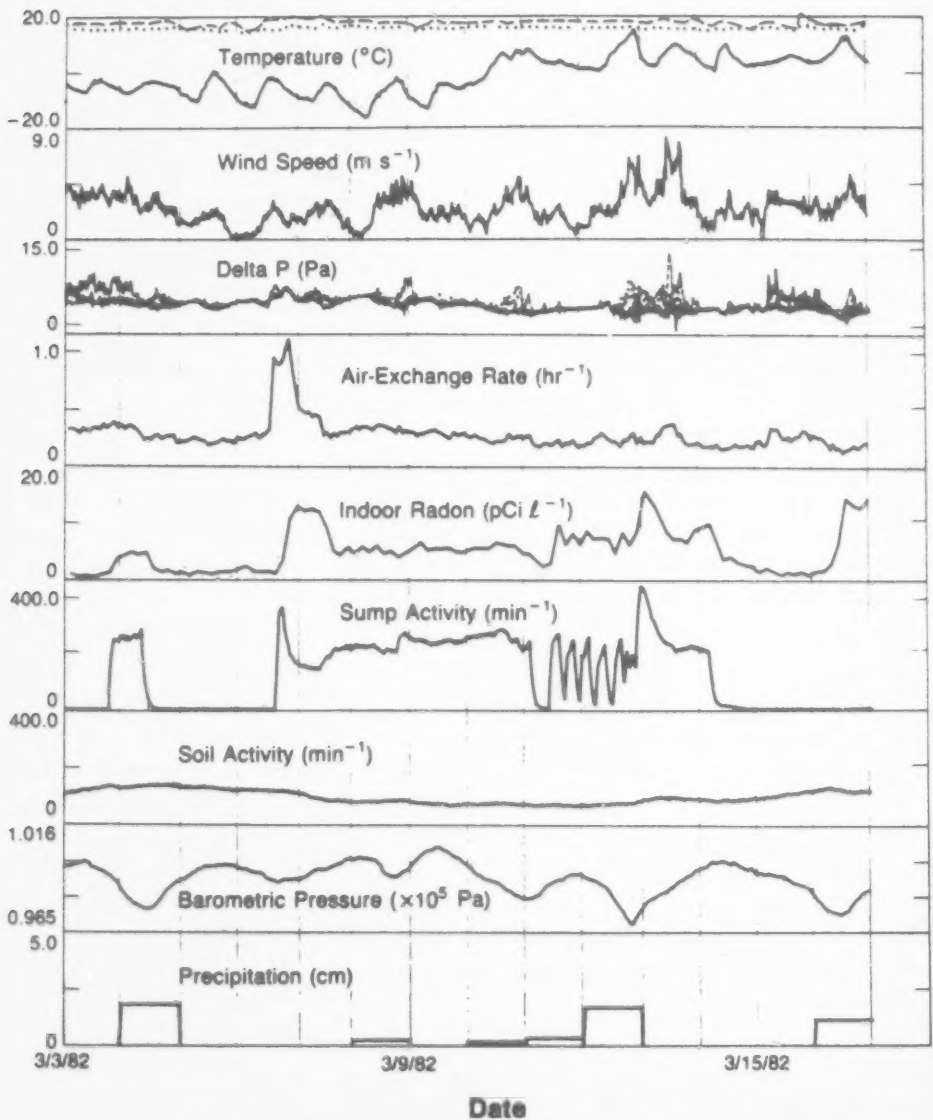


Figure 1.4. Variability of ^{222}Rn concentration, ventilation rate, and environmental parameters in a house with a basement. These data were accumulated over a 2-week period during a several-month experiment examining the dependence of radon entry on environmental factors. From Ref. 27.

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for the three cities included (25). These results, obtained with integrating samplers, are somewhat lower than comparable residential concentrations in the respective areas.

3.4 Time Dependence of Indoor Concentrations

Numerous measurements of radon in dwellings have indicated the substantial variation with time of concentrations of ^{222}Rn and its decay products. This variability occurs with time of day, weather conditions, or season. Without ascribing any cause to this variability—which is certainly related to environmental or operational parameters affecting radon entry or removal (or behavior of the decay products)—it is useful at this point to give one or two examples.

One of the earlier examples was obtained using continuous ^{222}Rn monitors in a New Jersey house, measuring basement and upper-floor concentrations over a period of weeks (26). A significant diurnal dependence was observed, consistent with later measurements, which however sometimes showed a stronger dependence.

More recent work has examined the dependence of concentrations on various factors, directly measuring not only the concentration, but also source parameters and environmental factors affecting radon entry and ventilation rates (27). An example of such real-time measurements is shown in Figure 1.4.

Detailed examination of such correlations is important for understanding radon entry and removal, as discussed later in this chapter and in Chapter 2. An appreciation of variability is also a key element in proper interpretation of monitoring results and effective selection of control measures (cf. Chapter 12).

4 SOURCES AND TRANSPORT

Radon arises from trace concentrations of radium in the earth's crust, and indoor concentrations depend on access of this radon to building interiors. Radon can enter directly from soil or rock that is still in the crust, via utilities such as water (and, in principle, natural gas) that carry radon, or from crustal materials that are incorporated into the building structure in the form of concrete, rock, and brick. The relative importance of these pathways depends on the circumstances, but it has become clear that the first—direct ingress from the soil—ordinarily dominates the higher indoor concentrations that have been observed in homes.

Indications of this arose in early investigations of radon in U.S. houses, when it was found that measurements of radon emanating from structural materials could not account for observed indoor concentrations, based on estimates of the air exchange rate (5). Moreover, practical experience in reducing concentrations in the Canadian mining communities made it clear that the major entry route was through the house understructure, at least in these houses.

A clearer picture emerged from the distribution of entry rates inferred from direct measurements of radon concentration and ventilation rate (such as the data shown in Fig. 1.3). Figure 1.5 shows such entry-rate distributions from various

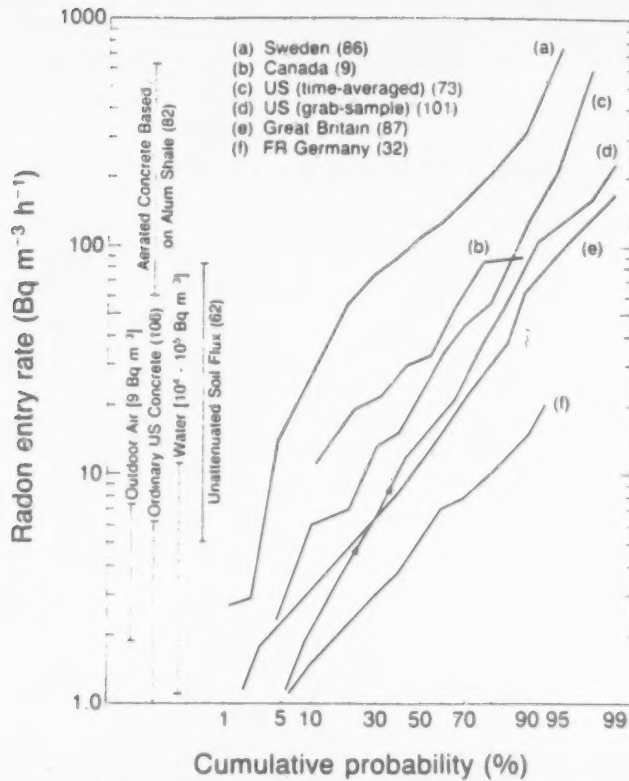


Figure 1.5. Cumulative frequency distributions of radon entry rates in dwellings. The entry rate is determined from the product of simultaneously measured radon concentration and ventilation rate. The number of residences in each sample is indicated in parentheses. The references from which these results are taken are: (a) 28, (b) 71, (c) 6, 27, 35, 72-74, (d) 7, (e) 75, and (f) 76. The bars at the left indicate the range of contributions expected from a variety of sources, with assumptions indicated in brackets. For each source, we have assumed a single-story house of wood-frame construction with a 0.2-m thick concrete-slab floor. The floor area and ceiling height are assumed to be 100 m² and 2.4 m, respectively; water usage is assumed to be 1.2 m³/day, with a use-weighted transfer efficiency for radon to air of 0.55; and the ventilation rate is assumed to be in the range 0.2-0.8 h⁻¹. References for estimates of source contributions are: outdoor air (62), U.S. concrete (29), alum-shale concrete (66); water (31); and soil flux (30). Figure taken from Ref. 77.

countries, as well as indicating the potential contribution of various sources. Although building materials were first suspected as the major source in the United States, based on the experience in Europe (e.g., Ref. 28), the initial U.S. results strongly suggested that the soil must be the major source (7). Understanding how the rate of radon entry could be approximately equal to the unimpeded flux from the ground (i.e., in the absence of the house) has been a major focus of research on radon entry, in both North America and Europe.

This section discusses briefly the current state of knowledge of radon sources and transport. Far more comprehensive treatments are given in Chapters 2, 3, and 4.

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4.1 Soil and Building Materials

Understanding the radon mass balance for a building requires specific consideration of the various sources. As indicated in Figure 1.5, a median (or GM) entry rate for U.S. single-family houses appears to be in the vicinity of $20 \text{ Bq m}^{-3} \text{ h}^{-1}$ ($0.5 \text{ pCi L}^{-1} \text{ h}^{-1}$). Based on emanation rate measurements from U.S. concretes (29), one might expect emissions from this source to account for a median of about $2\text{--}3 \text{ Bq m}^{-3} \text{ h}^{-1}$, far below the rate observed. On the other hand, the potential contribution from unattenuated soil flux, a median of about $25 \text{ Bq m}^{-3} \text{ h}^{-1}$ (based on Ref. 30), corresponds much more closely with the indoor observations. However, houses have understructures that might be expected to impede substantially the ingress of radon, at least by diffusion, the main mechanism for causing the observed fluxes from uncovered soil. As discussed in detail in Chapter 2 (and in Ref. 31), although transport via diffusion accounts well for observed fluxes from building materials and exposed soil and could account for small fluxes from the soil through some understructure materials (such as concrete), diffusion cannot account for the total entry rates observed in single-family houses. Another mechanism must account for the efficiency with which radon from soil enters such homes. It appears that this mechanism is bulk flow of soil gas driven by small pressure differences between the lower part of the house interior and the outdoors.

As discussed in Section 8.2 on ventilation rates, pressure differences of only a few Pascals—i.e., of the order of a ten-thousandth of an atmosphere—arise from winds and indoor-outdoor temperature differences and are precisely the cause of ventilation in homes during seasons when the windows are closed. These same pressure differences can, in principle, drive the small flows of soil gas needed to account for the observed rate of radon entry into homes: soil gas contains enough radon that, on the average, only 0.1% of infiltrating air would have to be drawn from the soil to account for observed indoor concentrations (31).

As discussed more fully in Chapter 2, recent work has begun to characterize directly and systematically the potential for pressure differences to cause entry of radon via soil gas, probably through imperfections and penetrations in the house understructure that permit passage of the relatively small amount of soil gas required. A study of radon entry in a single family house with a basement (see Fig. 1.4) analyzed the entry rate versus the ventilation rate, measured over a period of months, and concluded that entry could usefully be represented by a sum of two components: one—the smaller—independent of ventilation rate, much as diffusion would be, and a larger term proportional to ventilation rate, as pressure-driven flow might be (27). Moreover, the observed pressure and soil parameters appeared consistent with the soil-gas flow rate that was implied by the measured concentrations and ventilation rates. In addition, theoretical simulations of transport (e.g., Ref. 32) are helping to form a fundamental picture. Finally, recent experiments have directly observed, in houses with basements, the underground depressurization implied by this picture and have monitored underground soil-gas movement by injecting and monitoring tracers (33). A different kind of experiment—practical experience with remedial measures in such areas as Eastern Pennsylvania (34) and

the Spokane River Valley (12), using techniques such as those discussed in Chapter 10—is confirming and providing new information on the flow of radon-bearing air through house understructures. It is interesting to note that these results may also have significant implications for entry of other pollutants from the soil.

The studies of houses with basements have given results that may also apply in large part to slab-on-grade structures, where the pressure difference generated can still draw soil gas through any penetrations in or around the slab. However, few direct measurements in such structures have been performed. The other understructure type of substantial importance is the crawl space, which to some extent isolates the interior from the soil—at least with respect to pressure-driven flow between the two. Limited measurements of the transport efficiency of radon through crawl spaces yield the result that a substantial portion of the radon leaving uncovered soil manages to enter the interior, even if vents are open to permit natural ventilation of the space (35).

In retrospect, this is not entirely surprising, since the stack effect will tend to draw infiltrating air into the home from the crawl space, which can retain radon from the soil in conditions where winds are not sufficient to flush it to the outdoors via the vents. Furthermore, for structures where the vents are sealed shut, e.g., to save energy, it is conceivable that the crawl space still provides sufficient connection between the house interior and the soil that pressure-driven flow can enhance the flux from the soil above levels associated merely with diffusion; the work reported in Ref. 35 may have observed this effect. Another observation from this study is that energy conservation efforts that focus on tightening the floor above a crawl space can significantly reduce infiltration rates, while reducing radon entry a corresponding amount, as a result of which indoor concentrations are little affected.

Thus, sufficient mechanisms exist to account for the substantial amount of radon that appears to enter single-family homes from the soil, apparently without great regard to substructure type. However, this does not imply that other sources of radon are unimportant. As discussed in Chapter 3, it is clear that materials utilized in a building structure *can* contribute substantial indoor concentrations, although this is not usually the case (even for natural stone that has higher-than-average radium content). Moreover, in buildings that are relatively isolated from the ground, such as multistory apartment buildings, indoor concentrations are expected to be lower than average—as is often the case in central European dwellings—and to arise primarily from the building materials and from radon in outdoor air.

4.2 Water

Probably more important than building materials as a source of radon in certain parts of the housing stock is domestic water drawn from underground sources. Surface waters have radon concentrations too small to affect indoor levels when used domestically, but ground water is in a good position to accumulate radon

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generated within the earth's crust. As a result, very high radon concentrations can sometimes be found in associated water supplies. For example, a survey of ^{222}Rn concentrations in well-water in Maine found a range of 7×10^2 to $7 \times 10^6 \text{ Bq/m}^3$ (20–180,000 pCi/L), whereas wells in granitic areas were found to average $8 \times 10^5 \text{ Bq/m}^3$ (36). With normal water use, the radon entering indoor air from water with such high concentrations can be expected to be significant.

Examinations of the overall potential contribution of water-borne radon to indoor concentrations have tended to be no more sophisticated than to consider typical water use rates, house volumes, and ventilation rates, yielding a ratio of radon in air to radon in the water supply of about 10^{-4} . However, it is possible to make a more realistic estimate of the distribution of the air-to-water ratio, using more detailed distributional information (rather than just averages) on water use rates, efficiency of radon release from domestic water used in various ways, house volumes, and ventilation rates. Such an analysis of U.S. data for single-family houses yields a ratio with a lognormal distribution having a GM of 0.65×10^{-4} and a GSD of 2.88, as discussed in Chapter 4. Taken together with recently developed data on ^{222}Rn in public water supplies (37), such a distribution permits quantitative assessment of the contribution of public water supplies to indoor radon concentrations. The result of such an assessment is that such supplies contribute an average of approximately 1 Bq/m^3 (0.03 pCi/L) in the 30% of U.S. homes served by ground water, only about 2% of the average indoor concentration in U.S. single-family homes.

However, the very high water-borne concentrations that are sometimes found—particularly from private wells—must be expected to contribute much larger airborne concentrations in the homes affected. Using the few data that are available for the approximately 18% of the U.S. population using private wells, the indoor contribution from water for this segment of the housing stock can be estimated to average about 20 Bq/m^3 . About 10% of the houses served by these wells (totaling about 2% of the U.S. housing stock) are estimated to have indoor concentrations from water of 40 Bq/m^3 or more. Although these estimates for radon from private wells cannot be regarded as reliable, they suggest that the portion of the population using private wells may be experiencing significantly higher radon exposures than average, particularly in areas with high radon activity in water.

4.3 Summary of Source Contributions

We can thus point to the major sources of radon present in indoor environments. For single-family houses and other structures of one or two stories, the ground constitutes the principal source, but with a noticeable portion entering with outdoor air, i.e., on the order of 10 Bq/m^3 . However, there are circumstances in which the building materials or domestic water supplies are important. In contrast, in high-rise buildings, including apartments, the ground is of lesser importance, and the amount of radium-bearing building materials per unit volume is larger, so that outdoor air and the building materials are typically the dominant contributors, al-

TABLE 1.3 Approximate Contributions of Various Sources to Observed Average Radon Concentrations^a

Source	Single-family houses, Bq/m ³ (pCi/L)	High-rise apartments, Bq/m ³ (pCi/L)
Soil potential (based on flux measurements)	55 (1.5)	>0 (>0)
Water (public supplies) ^b	0.4 (0.01)	0.4 (0.01)
Building materials ^c	2 (0.05)	4 (0.1)
Outdoor air	10 (0.25)	10 (0.25)
Observed indoor concentrations	55 (1.5)	12? (0.3?)

^aIn each case, the arithmetic mean is shown, based on entry rates (or, in the case of outdoor air, concentrations) discussed in the text and on an air exchange rate of 0.5 h^{-1} .

^bIndicated water contribution applies to 80% of U.S. population served by public supplies. Contribution may average 20 Bq/m^3 in homes using private wells, with even higher contributions in high-activity areas.

^cThe contribution of building material in single-family houses corresponds to a slightly smaller geometric mean entry rate than that estimated in the text because not all houses are slab-on-grade or one-story. A higher contribution to apartment air is suggested on the presumption that, on the average, high-rise apartments have a larger amount of radium-bearing material per unit volume than do single-family homes.

though the ground and water supplies can be important in some cases. Other potential sources, such as natural gas, ordinarily contribute negligible amounts by comparison (38, 39).

For a specific set of assumptions, characteristic of U.S. buildings, Table 1.3 indicates the approximate average contribution of various sources to the indoor concentration for single-family buildings and (to the extent data are available) for apartments. For comparison, the observed concentrations are also given. Note that, considering the uncertainties involved, the presumed contributions are consistent with the observed levels, i.e., an average of 55 Bq/m^3 in single-family houses and a substantially smaller concentration in high-rise apartments.

Controlling Indoor Air Pollution

Airborne combustion products, toxic chemicals and radioactivity are more abundant indoors than outdoors. Should indoor air be regulated? If so, how? Putting risks in perspective helps to answer both questions

by Anthony V. Nero, Jr.

Because emissions from factories, power plants, waste dumps and automobiles can harm people as well as the biosphere in general, many countries have established extensive systems for identifying and controlling such pollution. Yet the greatest exposures to airborne combustion products, volatile toxic chemicals and radioactivity typically occur not outdoors but inside residences, offices and other nonindustrial buildings—settings that traditionally have been neglected by pollution-control agencies. Indeed, the health risks incurred merely by breathing the air at home can substantially exceed the general limits on risk that regulatory agencies impose in controlling pollutants in outdoor air or drinking water.

On the other hand, the risks from inhaling indoor pollutants are typically less than those associated with many voluntary activities that are regulated only marginally, if at all. By choosing to smoke cigarettes a person greatly increases the likelihood of later suffering from heart disease and lung cancer. Yet smoking is controlled indirectly in the U.S., where manufacturers are required only to print warnings on cigarette packages and in advertising.

The risks posed by indoor pollutants are in fact comparable in magnitude to those associated with exposure to chemicals or radiation in industrial settings. Living in certain houses and working at certain jobs are also similar in that both involve assuming some risk from exposure to pollutants in exchange for some

personal benefit (a home or a salary). Yet the approach for regulating occupational exposures, which is based primarily on setting concentration limits for each pollutant, would be extremely difficult to apply in controlling the quality of indoor air. The causes of indoor air pollution are so diverse and the concentrations are so variable that continual monitoring would be required in virtually all buildings—more than 80 million in the U.S. alone. Moreover, governments may hesitate to intrude into private houses in the name of pollution control, preferring merely to warn people of the dangers and let them decide for themselves whether or not to take action.

Although building codes could be rewritten to reduce the chance of having high pollutant levels in new structures, the incidence of buildings with indoor concentrations five, 10 or even 100 times the average justifies an active effort to find and fix such buildings now. The effort may affect hundreds of thousands of houses in the U.S., requiring as large an environmental program as has ever been undertaken. The scope of such a program, the variability in structures and pollutant concentrations and the balancing of personal choice, risk and benefit make construction of an effective and sensible overall strategy for the control of indoor air quality a daunting challenge to the research and regulatory community.

The pollutants found in indoor air are similar to those found outdoors and in some instances actual-

ly come from outdoor sources. Yet the pollutants measured in the highest concentrations indoors are those that arise from within buildings or their substructures. They reach such levels simply because they are emitted into a small volume—the indoor atmosphere—from which they cannot easily escape.

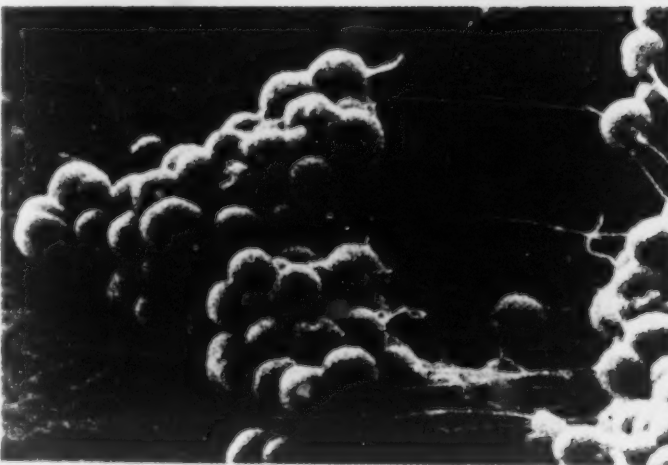
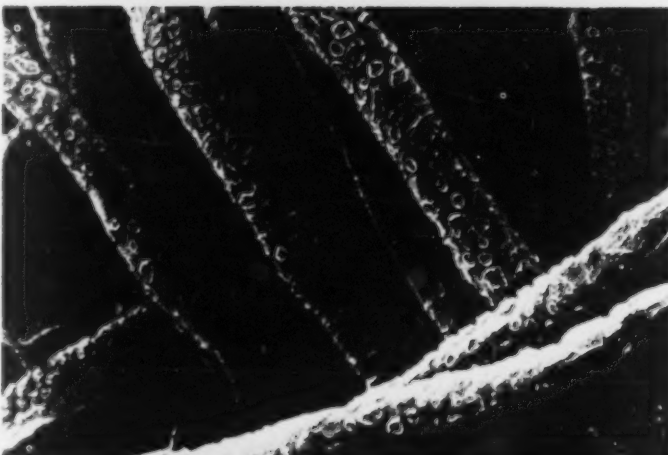
One of the most familiar indoor pollutants is cigarette smoke, which is composed mainly of organic aerosols, or tiny airborne particles. Heating and cooking appliances that burn natural gas, kerosene, oil and wood (or peat, coal and dung, as is the case in some countries) also emit varying quantities of respirable particles along with carbon oxides, nitrogen oxides and trace organic chemicals. Less familiar indoor pollutants include methylene chloride, formaldehyde and a vast range of more complex organic chemicals that are given off by building materials, furniture, cleaning fluids, pesticides, paints and paint strippers. Respirable fibers of asbestos can be released indoors from insulating material in older buildings. Indoor air pollutants even include the products of living organisms or the organisms themselves, such as bacteria, fungi and house mites. Perhaps most disconcerting for the occupants of many houses is the fact that the ground on which the houses sit is a major source of radon: a radioactive gas that is generated naturally as a product of the nuclear decay of radium, an element present in trace quantities throughout the earth's crust.

These classes of pollutants, which

are almost always present in indoor air, vary over a wide range of concentrations among residential and office buildings. The variability depends primarily on the rate at which each pollutant is emitted into the indoor atmosphere. A home with vented heating and cooking appliances (and without smokers), for example, will ordinarily not have high concentrations of combustion products in the air. Similarly, measurements of radon concentrations done in 100 U.S. houses in the late 1970's showed that differences in the entry rate of the gas accounted for most of the variability in the concentrations among the houses.

It is now understood that radon enters houses in the air that is drawn from the underlying soil by small differences in air pressure between indoors and outdoors. These pressure differentials (amounting to no more than .0001 atmosphere) arise in part from the "stack" effect: the tendency for air to rise whenever it is warmer than the surrounding atmosphere. (The stack effect is the working principle of a chimney.) Hence whenever it is warmer indoors than outdoors, air tends to flow in through the lower part and out through the upper part of a building's shell (its substructure, walls and roof). It does this by "infiltrating" through various openings, particularly around windows and doors and penetrations for pipes and wiring. Winds blowing against a building can also produce similar pressure differences—and thus airflows—across the building's shell, although the airflows exhibit a pattern substantially different from the patterns produced by the stack effect. Only a small part of the infiltrating air actually comes from the soil, but this is what carries the radon into houses. The entry rate of the gas therefore depends on the permeability of the soil to airflow, along with other geologic, meteorologic and structural factors.

The bulk of the infiltrating air actually comes from the outdoor atmosphere and accounts for the general ventilation of small structures such as houses. In contrast, large structures such as office buildings usual-



MICROORGANISMS found in ordinary household dust, such as mites (*top*), fungi (*middle*) and bacteria (*bottom*), are classified as indoor air pollutants because they can cause allergic reactions and other illnesses, as more familiar pollutants do.

ly rely on fans, air conditioners and ducts to provide ventilation.) A surprising amount of outdoor air manages to leak into a house by means of infiltration. In most houses outdoor air replaces the volume of indoor air every one to two hours.

Such an exchange of air represents a constant energy "drain," since energy has to be expended to heat or cool the outdoor air as it replaces the indoor air. Consequently in the mid-1970's energy-conscious homeowners in the U.S. and elsewhere began to reduce infiltration by weather stripping, plugging openings in the building's shell and caulking around windows and doors. Studies indicate that these measures reduce ventila-

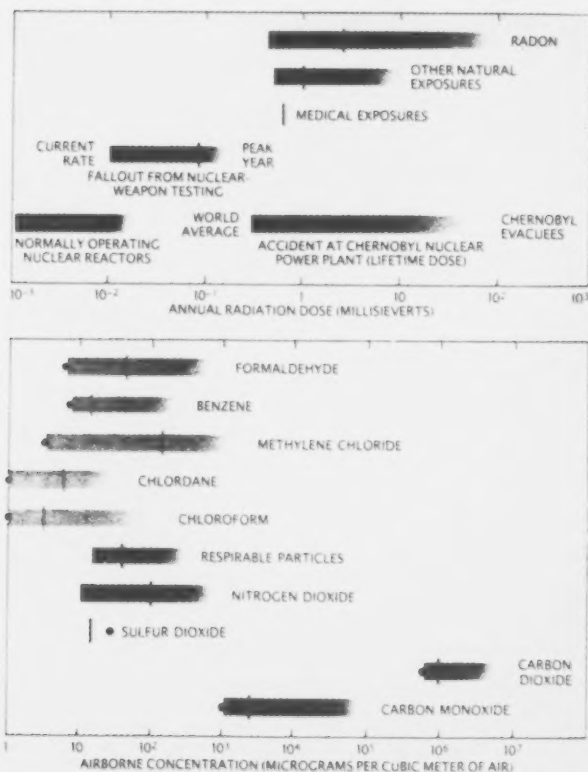
tion rates by roughly 10 to 30 percent, depending on how carefully the measures are implemented. While the modest decreases result in useful energy savings, the resulting changes in the concentrations of indoor pollutants are small compared with the ten- or hundredfold difference in concentrations observed between one house and another.

There is in addition a third factor that determines indoor pollutant concentrations: the rate at which a particular pollutant reacts with other airborne species or interior surfaces. Nitrogen dioxide, for example, is found to be removed from indoor air as much by such reactions as by ventilation. The chemical form and con-

centrations of radon's decay products (isotopes of polonium, lead and bismuth) also depend on the amount of airborne particles and the pattern of air movement in a particular building, influencing the radiation dose the products ultimately impart to the lungs when they are inhaled. Many other potentially important aspects of indoor-air chemistry remain virtually unexplored.

Taken together, the variability in entry rates, ventilation rates and reaction rates is the cause of an impressive range of concentrations for most indoor pollutants. No better example can be given than that of radon. In the U.S. concentrations in single-family houses vary over four orders of magnitude (factors of 10)—from a few becquerels per cubic meter of air to more than 10,000, with an average level of about 50 becquerels per cubic meter. (One becquerel is equal to one radioactive decay per second. Another common unit of measurement is the picocurie per liter, which is equal to 37 becquerels per cubic meter.) The average indoor level represents a radiation dose about three times larger than the dose most people get from X rays and other medical procedures in the course of their lifetime. Those exposed to higher levels receive proportionately higher doses. Indeed, hundreds of thousands of Americans living in houses that have high radon levels receive as large an exposure of radiation yearly as those people living in the vicinity of the Chernobyl nuclear power plant did in 1986, when one of its reactors exploded and released radioactive material into the environment.

The wide range of pollutant types and concentrations entails a correspondingly wide range of health risks. Cigarette smoke, asbestos fibers, the decay products of radon, formaldehyde and many other organic chemicals are demonstrated or potential carcinogens. Most of these pollutants can also lead to chronic or acute diseases, such as respiratory infections and allergic responses, as can combustion products in general and a variety of indoor bacteria and fungi. Extremely high levels of carbon monoxide—a combustion product—can even result in immediate death. Yet only in a relatively few cases, such as acute allergic reactions or carbon monoxide poisoning, is there a clear-cut relation between a given exposure to an indoor pollutant and an associated health effect. More often than not a given instance



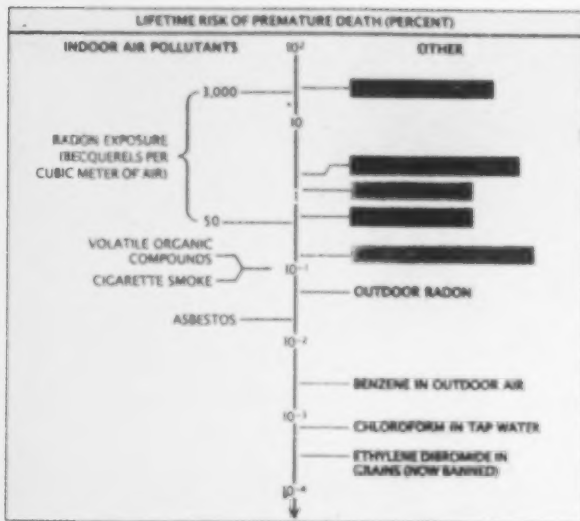
INDOOR AIR-POLLUTION LEVELS (bars), measured in terms of radiation exposure due to radon (orange), concentrations of organic chemicals (blue) and concentrations of combustion products (green), span orders of magnitude (factors of 10). Furthermore, the average indoor levels (lines) are generally higher than the average outdoor levels (dots). Exposures from other sources of radiation (red) are shown for comparison.

of respiratory disease or cancer cannot be directly attributed to a specific cause, environmental or otherwise.

Instead scientists study the occurrence of pollution-related diseases in heavily exposed groups (sometimes human beings but more often animals) in order to obtain probabilistic relations between exposures to pollutants and the chance that the diseases will appear in the general population. This approach provides the basis for estimating, albeit usually with substantial uncertainty, the risk of cancer and other diseases associated with the lower pollutant concentrations generally found in water and air, both indoors and outdoors.

In quantifying such health risks one must also consider the risk of suffering nonfatal diseases. Because these illnesses can occur with higher frequency, the overall risk they pose may be judged to be as important as, say, the risk of cancer. Yet it is difficult to treat all illnesses—fatal or otherwise—on a common basis; this would require an equivalence between days sick and days of life lost. It may also be inappropriate to do so, since acute illnesses such as allergic responses are immediately apparent to the sufferer, not merely hypothetical risks, as is the case with cancer.

In order to estimate the risks posed by indoor radon, for example, results from epidemiologic studies of underground miners who were exposed to high concentrations of radon's decay products are extrapolated to the lower exposures characteristic of a typical house. Based on these estimates, the average indoor concentration of radon in the U.S. corresponds to a chance of contracting lung cancer of about one in 250, or .4 percent, which would account for approximately 10,000 lung-cancer deaths per year in the country. Although the risk estimates for indoor radon exposure do have a degree of uncertainty, it is much less than for estimates of risk from other environmental-pollutant exposures, such as those from toxic chemicals, which are usually based on extrapolating doses and responses a thousandfold. In fact, no extrapolation is needed to estimate the health risks in houses with exceedingly high levels of radon. For example, people who have lived for 20 years in houses that have 1,000 becquerels of radon per cubic meter (which number in the tens of thousands in the U.S.) face an additional 2 or 3 percent chance of contracting lung cancer.



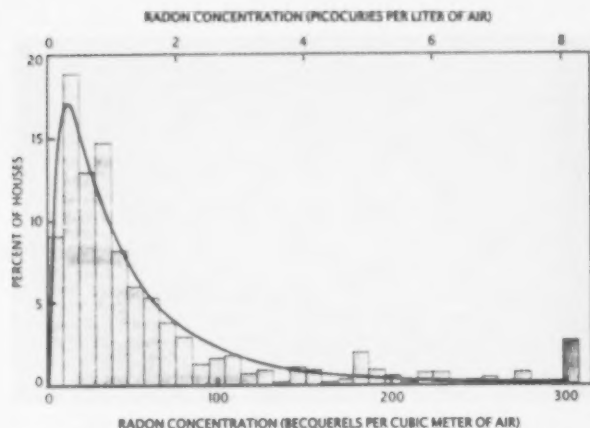
ESTIMATED PROBABILITY of suffering a fatal disease is substantially higher for exposure to indoor air pollutants (black) than for exposure to the pollutants in outdoor air, drinking water and food (pale red). The risk of death from exposure to indoor pollutants, however, is no more than that from certain voluntary activities (red), such as smoking, and occupational hazards (gray), such as those faced in mining uranium.

These figures are nothing short of remarkable. Pollutants in the outdoor environment are regulated so that the estimated risks of premature death from exposure to them are usually less than .001 percent. Indeed, just about the only environmental risks—at least for fatal disease—that are comparable to indoor radon arise from other indoor pollutants. Although the estimate is highly tentative, the risk of cancer arising from exposure to a wide range of organic chemicals in the indoor environment can be said to be about .1 percent. The risk of premature death due to typical exposures to asbestos is thought to be about .02 percent, with most of this risk resulting from indoor exposures. Both of these estimates require more than an order of magnitude greater extrapolation from epidemiologic or animal studies than the estimates of the risk associated with radon exposure. Finally, the risk of lung cancer attributed to breathing smoke from other people's cigarettes is estimated to be about .1 percent.

Yet the level of risk posed by pollutants at concentrations found in

doors is either in the same range as or lower than other risks that are accepted in exchange for some personal benefit. These risks include diseases caused by occupational exposures to toxic chemicals and work-related accidents as well as automobile accidents, which people are willing to accept—within reasonable bounds—in order to earn a salary or to have the convenience of personal transportation. The risk of death from automobile accidents, for example, averages about 2 percent in the U.S. People also seem willing to accept a 5 percent risk of dying in a fall or fire at home in return for the comfort of living indoors. Many are even ready to accept the 30 percent risk of premature death associated with smoking—a risk that is rivaled only by exposure to the highest indoor radon levels known—for the sake of personal pleasure.

How, then, can one approach the problem of indoor air pollution, which entails risks that exceed common "environmental" risks but not the risks people tacitly accept when driving, smoking or simply living



DISTRIBUTION OF RADON CONCENTRATIONS suggests that about 2 percent of the houses in the U.S. (numbering some one million) have concentrations greater than or equal to 300 becquerels per cubic meter of air, which is five times the average level.

in houses? Any overarching strategy for controlling the risks associated with indoor-pollutant exposures requires three basic, interdependent elements: a system of advisory or regulatory standards that determines the overall attack on the problem, a methodology for identifying the situations of greatest concern and a framework for selecting control techniques suited to each situation.

The underlying system of standards can take fundamentally different forms, depending on the objectives. One objective might be to control the average exposure of the entire population; a contrasting objective is to avoid extreme levels, thereby limiting individuals' risk of disease, fatal or otherwise. In any case, the objectives can be achieved by formulating standards that either control the factors affecting pollutant concentrations or establish limits on the concentrations themselves.

Actually both types of standard are applied in the control of outdoor pollution. The release of pollutants from automobiles and power plants, for example, has been controlled by standards that modify such factors as combustion processes. Concentration limits in turn are embodied in standards for outdoor air and water, which are meant to protect the population at large to a higher degree than individuals who are exposed to the same pollutants in the workplace.

Concentration limits for outdoor air usually apply to a large environmental region—an "air basin," such as that of Los Angeles—so that exposures are more or less consistently limited throughout a large population. Because conditions vary greatly from one building to another, a comparable approach to controlling indoor pollution would entail dealing with some 80 million air-quality-control "districts" in the U.S.—one for each building. As a result concentration limits for indoor pollutants are most effectively aimed at avoiding excessive individual exposure rather than controlling the average exposure of a population.

The fact that the indoor environment has significant inherent risks has to be recognized and near-term attention focused on the exceptional situations—including truly high levels of radon, organic chemicals or combustion products, as well as the occasional excessive levels of flaking asbestos and even house mites. This approach contrasts sharply with suggestions to limit formaldehyde concentrations to zero (within the limits of instrumental sensitivity) or to limit indoor radon concentrations to outdoor levels (about 10 becquerels per cubic meter of air). These proposals do not appear to recognize that the risks associated with average exposures to formaldehyde and radon are solidly within the range

of risks that are normally accepted.

Nevertheless, average exposures to indoor pollutants can also be gradually lowered as a long-term goal. This can be achieved by establishing standards that regulate the factors affecting indoor-pollutant concentrations. For this reason it is important to identify how source, ventilation and structural characteristics affect the concentrations. Such knowledge can be applied in the formulation of specific criteria for the design, fabrication and utilization of new buildings and furnishings that will ensure acceptable indoor air quality in the great majority of cases.

Studying the behavior of indoor pollutants also helps in the development of a methodology by which to identify buildings that have or are likely to have excessive pollutant levels. For example, knowledge that certain materials or appliances are often associated with high levels of organic pollutants or combustion emissions can lead to monitoring in buildings containing those products. Similarly, analysis of the general geologic, architectural and meteorologic factors affecting indoor radon concentrations might serve to identify regions where excessive levels are likely to occur.

Once a building has been identified as needing remedial action (whether it is already constructed or still in the planning stages), control techniques can be implemented. A number of control techniques have already been developed, corresponding roughly in both design and effectiveness to the fundamental factors affecting indoor concentrations. Given that the emission or entry rate is the primary determinant of concentration levels, measures to reduce pollutant sources provide the primary control—assuming that ventilation rates are in the normal range. Emissions of formaldehyde and other volatile organic substances, for instance, can be lessened by changing the way particle board, adhesives and other products are manufactured. Good burner and exhaust designs in heaters and cooking appliances can decrease the concentration of combustion products. Entry of radon from the ground can be diminished markedly by means of simple systems of pipes and fans that draw air from (or blow air on) the soil or gravel immediately under the substructure of a house.

If it is determined that neither infiltration nor opening windows is suffi-

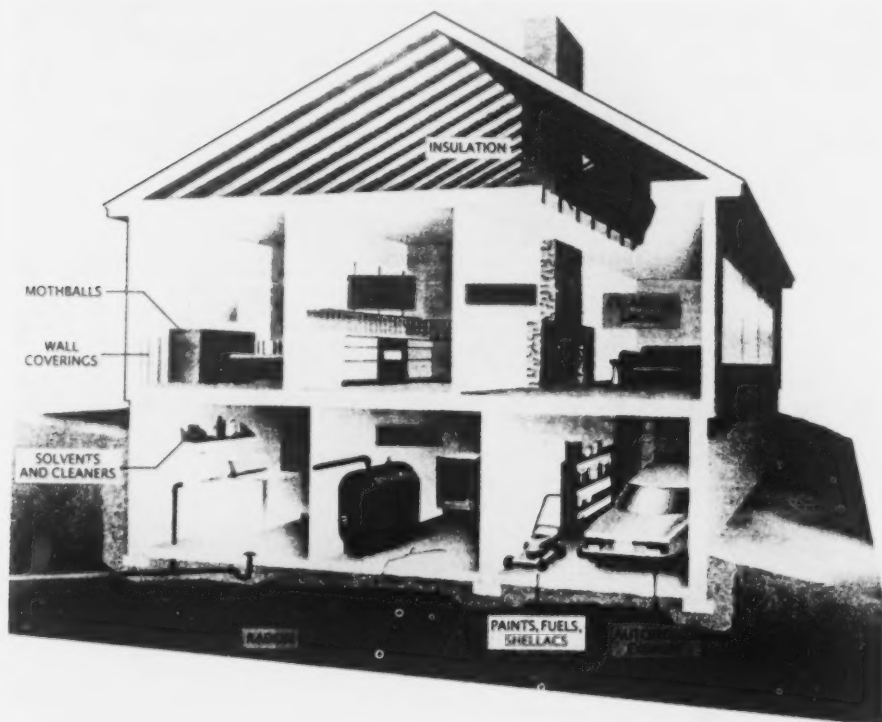
cient to ensure an adequate ventilation rate, mechanical systems can be installed. In large buildings these systems can be quite complex, designed to meet performance criteria that are often incorporated into building codes. In houses with little infiltration much simpler systems can be employed, such as a single exhaust fan. (To save energy the system can be designed so that exhaust and intake airstreams exchange heat.) Although infiltration and mechanical ventilation can provide a basic level of protection, they cannot be relied on to reduce pollutant concentrations substantially: the required increase in ventilation rate would ordinarily be more difficult and more costly to achieve than eliminating or

reducing the source of the pollutants.

An alternative means of control might be to physically clean the air of airborne gases or particles. This approach suffers some of the same limitations as ventilation, namely that marked reductions in pollutant concentrations would require high rates of processing the air. In fact, many of the less expensive and popular tabletop air cleaners provide only very low and generally inadequate cleaning rates. Of more concern is the fact that better devices may not even reduce the overall exposure. For example, in drastically reducing the total concentration of radon's decay products, filter systems and electrostatic precipitators (which remove particles suspended in air by imparting an

electric charge to them) increase the fraction of the decay products that are not attached to airborne particles. Unfortunately the free decay products appear to cause the greater radiation dose to the lung. Hence in spite of the fact that air cleaning may reduce the total concentration of radon's decay products, it does not necessarily reduce the exposure to radiation.

Air cleaning may find a role in control of biologic particles, such as bacteria, fungi or residue from house mites, that do not behave like chemical or radioactive pollutants. In particular these organisms actually multiply given the right conditions, requiring a different perspective on control. The most effective approach



SOURCES OF AIRBORNE POLLUTANTS In a typical house are myriad. Combustion products (*green*) are traced to cigarette smoke, heating and cooking appliances and perhaps automobile exhaust. Organic chemicals (*blue*) are given off by substances in

paints, plywood, solvents and adhesives. Radon (*orange*) is drawn into a house by small differences between outside and inside air pressure; the gas seeps through cracks in the house's foundation and through openings around loose drainage pipes.

In their case would be to combine air cleaning or increased ventilation and a reduction in indoor humidity.

Current efforts to control indoor air quality have in fact followed the two basic approaches: setting spe-

cific concentration limits and modifying the design and manufacture of buildings and their contents. The Netherlands has adopted standards limiting indoor formaldehyde concentrations to 120 micrograms per cubic meter, and Canada has set a limit of 150 becquerels per cubic meter for indoor radon in uranium-mining communities. West Germany and the U.S., on the other hand, have set standards that limit formaldehyde emission from wood products, such as plywood, and have considered regulating the emissions from unvented fossil-fuel heating appliances. Policymakers, however, have come to acknowledge their naiveté in adopting concentration limits as the primary basis for control: emission and ventilation standards have been found to be more workable.

Attempts have also been made in recent years to include optional concentration limits for identified classes of pollutants as part of the ventilation standards incorporated into building codes. This illustrates a dangerous tendency to expand each of the approaches in an overall control strategy to include the other, leading to an overt or implicit confusion of objectives. A self-consistent and comprehensive strategy would rely on the factors that determine ventilation and emission rates as "handles" for keeping concentrations within (implicitly) acceptable ranges in most new buildings and adopt explicit concentration limits mainly as criteria for reducing truly excessive levels found in existing structures.

In spite of the confusion in objectives, there at least is some consensus on where the major responsibilities lie for implementing control strategies. This consensus is important, because many actors are directly involved. They include national and local government agencies, professional organizations, manufacturers of building materials and household appliances, builders and contractors. For that matter, anyone who is active in issues of health, environment, housing, energy and consumer products as well as in related areas such as demography, meteorology and geography should necessarily be involved.

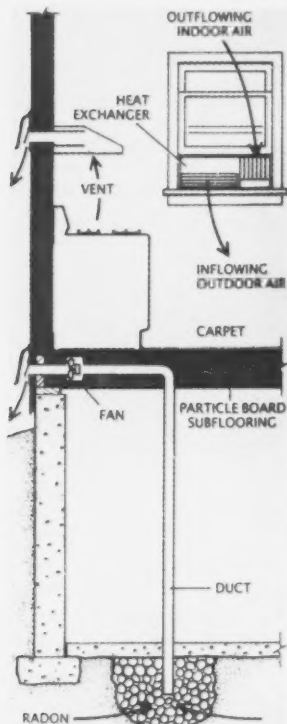
Yet the success or failure of a program to control indoor air quality ultimately hinges on the behavior of the owners and occupants of buildings. At present occupants are often not aware of potential health problems caused by the way they use certain appliances or substances—or for

that matter of the effect they have on others by smoking cigarettes in enclosed spaces. Even building managers may not know for what activities the building was originally designed or how the ventilation equipment in the building is meant to be operated.

For this reason some local governments are considering requiring every manager of a building to conform to the assumptions made in its design. In this way a chain of responsibility from the engineer, architect and builder to the owner and occupants can be maintained. An important element in such a system might be a supporting document associated with a building, much like a deed, that describes the design assumptions relevant to indoor air quality and records changes in the building's occupancy or ventilation equipment. In the case of office buildings the document could list a building's smoking areas and indicate the extent to which furnishings that emit organic chemicals can be used.

A simpler document for private houses could maintain a record of radon measurements and of any remedial techniques and maintenance procedures that may be needed. It would be similar to the document required in many areas that certifies a house for sale is free of termites. Indeed, in areas where high radon concentrations have been reported real-estate transactions are already including this information. Such a document would be one of the more visible manifestations of a comprehensive control strategy.

The control of indoor air pollution goes beyond the conceptual basis of current regulatory structures, which were built for controlling exposures to pollutants in industrial or outdoor settings. The fact is that the health risks posed by indoor pollutants have to be considered in their own right, and the objectives and approaches for a rational pollution-control strategy must be thought out anew. Such rethinking depends on science to evaluate the health risks, elucidate the correlation between pollutant concentrations and the factors that influence them, develop methods for measuring pollutant concentrations and determine the effectiveness of control techniques. The resulting science and policy of indoor air quality might even change how we think about other pollutant exposures, leading to a more realistic perspective on environmental risks in general.



CONTROL MEASURES seek to lower concentrations of pollutants by lowering the rate at which they enter the indoor atmosphere or by increasing the rate at which outdoor air replaces indoor air. The amount of formaldehyde released from particle board and carpets can be reduced by changing the resins and binders used in their manufacture. Venting a cooking range usually results in a marked drop in the concentration of combustion products. The rate at which radon enters a house can be lowered by reducing the air pressure under the building. This can often be done by means of a single fan and a duct. Finally, heat exchangers can improve a house's general ventilation rate without significantly increasing energy costs, since they heat or cool inflowing outdoor air with outflowing indoor air.

THE AUTHORS

ANTHONY V. NERO, JR. ("Controlling Indoor Air Pollution"), is principal investigator and coleader of the building-ventilation and indoor-air-quality program at the Lawrence Berkeley Laboratory (LBL) of the University of California, Berkeley. After completing a doctorate in physics at Stanford University in 1971 and postdoctoral work at the California Institute of Technology, he was made assistant professor of physics at Princeton University. He has been at the LBL since 1975. Nero, who spent a year at the U.S. Arms Control and Disarmament Agency and has published a guidebook to nuclear reactors, says that over the years he has become increasingly interested in how society makes decisions on technological, environmental and health issues.

RICHARD E. SLUSHER and BERNARD YURKE ("Squeezed Light") are experimental physicists at the AT&T Bell Laboratories. Slusher earned his Ph.D. at the University of California, Berkeley, in 1965. He has studied interactions between laser light and many forms of matter: semiconductors, solid helium, tokamak plasmas and beams of atoms. He is now head of the department of solid-state and quantum physics at the Bell Laboratories, where he is seeking to understand the fundamental limits of optical nonlinearities in materials. Yurke got his Ph.D. from Cornell University in 1983; he went to the Bell Laboratories to develop his many ideas for generating and detecting squeezed light. These ideas matched Slusher's experimental resources and a fruitful collaboration was born. Yurke's current experiments are aimed at generating squeezed microwave radiation at ultralow temperatures.

LLOYD J. OLD ("Tumor Necrosis Factor") holds the William E. Snee Chair of Cancer Immunology at the Memorial Sloan-Kettering Cancer Center in New York. He has worked there in a variety of capacities since 1958, the year he received his M.D. at the University of California School of Medicine. From 1973 to 1983 he served as vice-president and associate director of scientific development at the Sloan-Kettering Institute for Cancer Research. His early experience as a fellow at Sloan-Kettering convinced him to dedicate himself to cancer research rather than clinical

practice. For the past 20 years he has focused much of his attention on a search for cancer-specific antigens. The work has led to a detailed study of antibody responses to tumor cells in patients who have melanoma and to the development of a melanoma-vaccine program. Old is also medical director of the Cancer Research Institute, an organization that supports fellowships and grants in the area of cancer immunology.

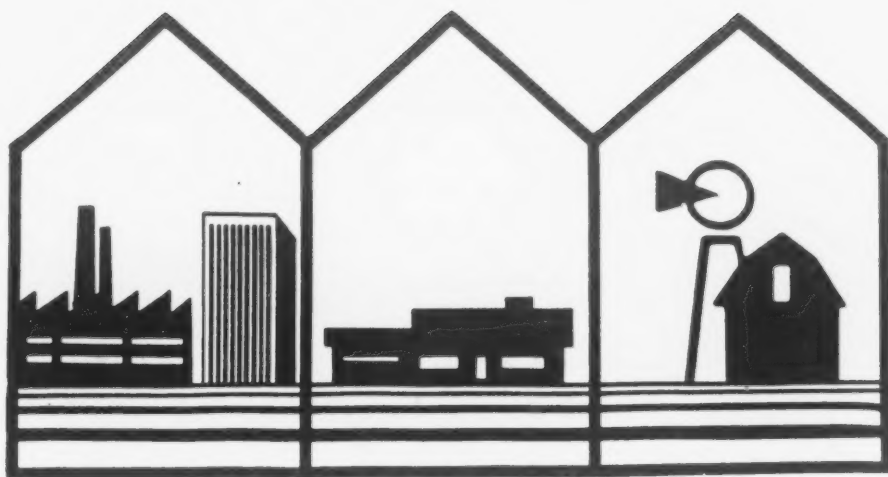
KENNETH A. HOFFMAN ("Ancient Magnetic Reversals: Clues to the Geodynamo") is professor of physics at the California Polytechnic State University in San Luis Obispo and an editor of the *Journal of Geophysical Research* (Solid Earth and Planets). He got his bachelor's degree in physics in 1966 and his Ph.D. in geophysics in 1973, both from the University of California, Berkeley. He then did postdoctoral work at the University of Minnesota before going to California Polytechnic in 1974. Hoffman, who has spent much of the past decade studying the process of geomagnetic reversal, has been an author or coauthor of the past three quadrennial reports on geomagnetic reversal submitted by the U.S. national committee of the Union of Geodesy and Geophysics to the international organization. He is currently conducting paleomagnetic investigations on Molokai in Hawaii and on Réunion Island in the Indian Ocean.

MERVYN GRIFFITHS ("The Platypus") retired in 1975 as a principal research officer in the Division of Wildlife at the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia. He now studies milk secretion by monotremes and marsupials as an honorary research fellow at the CSIRO and as a visiting fellow at the John Curtin School of Medical Research of the Australian National University. He got his bachelor's, master's and doctoral degrees from the University of Sydney between 1937 and 1959; during that period he also won a scholarship that allowed him to study physiology at other institutions, and he served for four years in the Australian air force. He went to the CSIRO in 1959 and it was there that he became particularly interested in the evolution of marsupials and egg-laying mammals.

JOCHEN FRICKE ("Aerogels") is professor of experimental physics at the University of Würzburg in West Germany. He received a Ph.D. in physics in 1967 from the Technical University of Munich. He then spent two years as a postdoctoral research fellow at the University of Pittsburgh. He has been editor of the German physics magazine *Physik in unserer Zeit* since 1970. Fricke's research interests now center on the optimization of thermal superinsulations, the properties of highly porous solids and questions of scaling.

FRANCIS P. MCMANAMON and JAMES W. BRADLEY ("The Indian Neck Ossuary") worked together on the National Park Service's excavations of the ossuary and other sites on the Cape Cod National Seashore. McManamon, who is chief of the Park Service's Archaeological Assistance Division, got his Ph.D. from the State University of New York at Binghamton in 1984. He has a long-standing interest in the prehistory of northeastern North America, archaeological techniques, and historic preservation, and he recently began to study the archaeology of the Pacific coast. Bradley is director of preservation planning for the Massachusetts Historical Commission. He holds a doctorate from Syracuse University and has written extensively about early contact between native Americans and Europeans and the resulting processes of cultural change. Bradley's book *Evolution of the Onondaga Iroquois: Accommodating Change: 1500-1655* was recently published by the Syracuse University Press.

LARRY ABBOTT ("The Mystery of the Cosmological Constant") is associate professor of physics at Brandeis University. He earned his Ph.D. in physics from Brandeis in 1977. He joined the faculty there in 1979 after working at the Stanford Linear Accelerator Center and at CERN, the European laboratory for particle physics in Geneva. Abbott writes: "Over the past several years I have been interested in the application of new ideas in particle physics to cosmology and have worked on inflationary cosmology, dark matter and the large-scale structure of the universe. At the same time I have become intrigued by the problem of the cosmological constant. More recently I have studied the implications of the observation of neutrinos from supernova 1987A and have become interested in the physics of neural networks."



Statement of the
NATIONAL ASSOCIATION OF REALTORS®
THE WORLD'S LARGEST TRADE ASSOCIATION

TO: HOUSE COMMITTEE ON SPACE, SCIENCE AND TECHNOLOGY
 SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE
 RESEARCH AND ENVIRONMENT

SUBJECT: H.R. 5373, ESTABLISHING AN EXPANDED INDOOR AIR QUALITY
 PROGRAM WITHIN THE ENVIRONMENTAL PROTECTION AGENCY

DATE: SEPTEMBER 28, 1988

WRITTEN STATEMENT OF THE
NATIONAL ASSOCIATION OF REALTORS®
ON INDOOR AIR QUALITY LEGISLATION
BEFORE THE
HOUSE COMMITTEE ON SPACE, SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
September 28, 1988

I. Introduction

On behalf of the more than 800,000 members of the NATIONAL ASSOCIATION OF REALTORS® (NAR) I would like to thank the Chairman and members of the Subcommittee on Natural Resources, Agriculture Research and Environment, for the opportunity to present our views on H.R. 5373, establishing an expanded indoor air quality program within the Environmental Protection Agency (EPA). The NATIONAL ASSOCIATION OF REALTORS® (NAR) is the world's largest trade association and represents almost every aspect of the real estate industry. Among the affiliated groups are the Society of Industrial and Office REALTORS®, the Institute of Real Estate Management, and the American Institute of Real Estate Appraisers.

Everyday we are given more information through newspaper articles and television reports on pollutants in our environment and their physical and emotional impact on our lives. Scientists are now discovering that pollution

in our indoor living and working environment may also have an impact on our ability to lead normal, healthy and productive lives. For years we heard about contaminants such as asbestos and radon and their long term effect on our health. Most recently, we've begun to learn about "sick building syndrome" and its wide range of temporary health-related side effects such as headaches, sinus problems and nausea.

The NATIONAL ASSOCIATION OF REALTORS® strongly believes that every individual should have the opportunity to live in safe and decent housing. At our recent Legislative Meetings held this past May, the NAR Board of Directors adopted the policy that all Americans are entitled to enjoy an indoor living environment where risks to health and welfare from pollution are minimized. NAR supports increased efforts by both the private and public sectors to characterize and evaluate the extent of indoor air quality problems and to encourage the development of meaningful and affordable monitoring and mitigation strategies.

The NATIONAL ASSOCIATION OF REALTORS® continues to play an active and positive role in the indoor air quality debate, and has participated in numerous work groups, seminars, and conferences on indoor air quality issues such as asbestos and radon. Although the real estate industry works together closely in examining these issues, it must be remembered that the individual trade associations represent different interests and therefore, have developed distinctive policies on indoor air quality.

One example of the NAR effort to inform and educate REALTORS® about indoor air quality issues was our production and distribution of thousands of radon information kits to REALTORS® and the public. (Incidentally, these kits were available long before the publication of the U.S. Environmental Protection Agency's radon booklets). Two years ago, the REALTORS® Hazardous Substances Task Force produced a manual to educate REALTORS® on a variety of hazards they may encounter in the field, including indoor radon and asbestos. The NATIONAL ASSOCIATION OF REALTORS® continues to meet with officials of the federal government as well as members of the scientific community to discuss various technical and public awareness problems related to indoor air quality.

II. Legislation

The NATIONAL ASSOCIATION OF REALTORS® supports the approach taken in H.R. 5373 which comprehensively addresses the indoor air quality issue rather than reviewing and legislating on each pollutant individually. The many benefits to this approach include the capacity to examine and ultimately treat categories of indoor air contaminants that alone may pose little or no threat to the health of building occupants. The legislation authorizes much needed funds to states for the development of programs to address indoor air contamination.

III. Indoor Air Quality Research

H.R. 5373 lists many areas of research that EPA is responsible for carrying out. However, such a lengthy list of research priorities can diminish the ability of EPA to prioritize certain key elements of indoor air quality research that should be brought to the forefront quickly. For example, according to the National Institute of Occupational Safety and Health (NIOSH), over 50% of current indoor air problems can be aided through better understanding and operation of HVAC systems. While improved ventilation is not a panacea for all indoor air problems, it should be clearly identified as a top priority for EPA research and development. While all of the research needs identified in Sec. 5(a) and (b) are important, prompt attention by EPA on ventilation strategies could have an immediate impact on the quality of air in thousands of buildings. People could be enjoying improved air quality while EPA continues to work on the 17 other research priorities outlined in Section 5(b).

Another of the bill's research objectives that should be clearly identified for priority emphasis is the contribution of building materials and consumer products to indoor air quality degradation. With so many research objectives for EPA to fulfill, we believe that careful examination of these two sources of possible indoor contamination and of subsequent control

strategies could result in a more immediate response to the public health problem than some of the other research needs. Passage of the Waste Reduction Act (H.R. 2800) by the House recognizes the value of preventative measures in reducing the need for more complex and costly after the fact mitigation efforts. Prevention of contamination at the source needs priority attention.

A third research objective that should be clearly identified for priority is the identification of the optimal means for dissemination of informational documents on indoor air contamination. H.R. 5373 utilizes technology and management practice assessment bulletins in Section 5 and health advisories in Section 6 as the primary means of information dissemination. However, it is not clear that information dissemination is best achieved by these technology bulletins and health advisories.

IV. Information Dissemination

When Congress resumes with indoor air hearings in 1989, we urge a careful examination of current Environmental Protection Agency, Department of Energy, and Consumer Product Safety Commission programs for technology transfer and risk communication to the public. These agencies have a great deal of experience in these two areas and their existing programs can be evaluated to

determine what additional means of communicating indoor air quality information to the building owner, the architect or engineer, maintenance personnel, and building occupants would be most effective.

The EPA's radon program has been extremely successful in heightening public awareness to radon through the publication of the Citizen's Guide to Radon and Radon Reduction Methods. These documents, as well as EPA's recent press conference announcing the results of its seven state survey, have had a positive impact on Americans testing their homes. We feel the lessons learned from the radon program are valuable and can be applied to other indoor air quality programs. Under H.R. 5373, technology bulletins and health advisories are developed and distributed in a somewhat awkward manner. The legislation should be modified to produce documents for public dissemination that are more timely, that discuss health risks at elevated levels of indoor pollutants, and simultaneously discuss state-of-the-art control and monitoring methodologies and costs.

Under H.R. 5373, a listing procedure is developed for every contaminant found in the indoor environment to help EPA develop its health advisories. Again, with limited resources at the Agency, there are more useful ways for EPA to expend its time and funds. Many textbooks and professional journals can provide a list of indoor air contaminants. Additionally, the listing

process itself detracts from the major thrust of the bill that groups of pollutants, rather than individual contaminants, should be studied and controlled. What is needed is a mechanism to help EPA focus on those pollutants that present real and significant risks to the public.

Likewise, information dissemination through the use of "health advisories" under H.R. 5373 can thwart the ability of the Administrator to concentrate on the more significant indoor contaminants. Under this legislation, health advisories (at least six in 18 months) are to be issued on individual contaminants regardless of their frequency of occurrence or their significance to health. The advisories must list at what level a zero risk can be obtained, whether or not it is technologically feasible. Finally, the fact that health advisories are pollutant specific again seems to contrast with the bill's intent to focus on research and mitigation strategies relating to groups of contaminants. We urge that Congress review and re-evaluate the mechanisms it wants EPA to utilize for public information dissemination.

V. Office of Indoor Air Quality

Section 10 of H.R. 5373 would be strengthened if the Office of Indoor Air Quality was subject to review of the Office of Toxic Substances, as well as the Office of Air and Radiation. OTS has a history of dealing with a variety

of toxic chemicals such as formaldehyde and pesticides. Much of the preventative nature of indoor air contamination will require an understanding of the chemistry and the manufacturing of consumer products and building materials. The Office of Toxic Substances can provide this kind of expertise and should have a major involvement in developing mitigation strategies.

VI. NIOSH Building Assessment

H.R. 5373 includes the codification of the current National Institute of Occupational Safety and Health regulations regarding building assessments. The function and value of this program need to be explored by this Committee.

Additional hearings on indoor air quality in the 101st session of Congress should include an examination of the NIOSH program. NIOSH representatives, union representatives, and building owners who have been involved with the NIOSH program could provide the Committee with the information it needs to determine the appropriate role of NIOSH in EPA's indoor air efforts.

VI. Conclusion

We are pleased and encouraged that Congress is addressing the serious issue of indoor air quality and its effect on our health and welfare. The NATIONAL ASSOCIATION OF REALTORS® will continue to take a lead role on this

issue and remains dedicated to the further education of our membership as well as the general public to the hazards that are present in our indoor environment. We look forward to working with this Subcommittee during the 101st Congress in developing comprehensive indoor air quality legislation that provides necessary scientific research on the health risks posed by contaminants, and encourages government and the private sector to develop workable testing and mitigation practices.

Respectfully submitted,

A handwritten signature in dark ink, appearing to read "Nestor R. Weigand, Jr.", with a stylized flourish at the end.

Nestor R. Weigand, Jr.

President



1125 Fifteenth Street, N.W.
Washington, D.C. 20005

Mortgage Bankers Association of America

Barton C. Wood
Senior Staff Vice President
and Legislative Counsel
202-861-6507

October 20, 1988

The Honorable James Scheuer
Chairman
Subcommittee on Natural Resources,
Agricultural Research and Environment
Committee on Science, Space and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

On behalf of the Mortgage Bankers Association of America, I am enclosing a statement in connection with the hearings on HR 5373, the "Indoor Air Quality Act," which we respectfully request be included in the hearing record. We appreciate the opportunity to comment on this legislation, and to work with the Subcommittee in developing a legislative response to the problems of indoor air.

Sincerely,

A handwritten signature in dark ink, which appears to read "Barton C. Wood". The signature is written in a cursive, flowing style.



1125 Fifteenth Street, N.W.
Washington, D.C. 20005

202-861-6500

Mortgage Bankers Association of America

STATEMENT OF

MORTGAGE BANKERS ASSOCIATION OF AMERICA

SUBMITTED FOR THE HEARING RECORD ON
HR 5373, THE "INDOOR AIR QUALITY ACT OF 1988"

SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

September 28, 1988

The Mortgage Bankers Association of America (MBA)* appreciates this opportunity to present the Subcommittee with its views on the HR 5373, the "Indoor Air Quality Act of 1988," and the issue of indoor air quality. MBA shares the Subcommittee's concern regarding the impact of the indoor air environment on public health, and applauds its effort to address the issue by beginning hearings in this session. The Subcommittee's action on this issue is timely. The hazards of indoor air pollution have been with us for many years. However, the number and kind of potential hazards emitting pollutants into indoor air, which can permanently or temporarily damage human health, has increased in recent years. Ineffective ventilation systems can hinder evacuation of emissions from the many new chemicals and substances used in building materials, and household and office products. Design and construction techniques implemented in the 1970's to achieve greater energy efficiency have resulted in the retention of both pollutants and natural indoor air hazards, such as radon.

MBA's interest in the indoor air issue stems from a genuine concern about public health and a recognition that indoor air problems may affect property values and require significant expenditure of funds. MBA represents lenders, who become owners if a default occurs. Our members provide short and long term financing for properties, and thus serve as (1) lenders (and sometimes equity participants) who provide capital for new construction and acquisition, (2) holders of security interests on existing properties which may or may not have indoor air problems,

*The Mortgage Bankers Association of America is a nationwide organization devoted exclusively to the field of housing and other real estate finance. MBA's membership comprises mortgage originators and servicers, as well as investors, and a wide variety of mortgage industry-related firms. Mortgage banking firms, which make up the largest portion of the total membership engage directly in originating, selling, and servicing real estate investment portfolios. Members of MBA include:

- | | |
|---------------------------------|---------------------------------|
| - Mortgage Banking Companies | - Mortgage Brokers |
| - Commercial Banks | - Title Companies |
| - Mutual Savings Bank | - State Housing Agencies |
| - Savings and Loan Associations | - Investment Bankers |
| - Mortgage Insurance Companies | - Real Estate Investment Trusts |
| - Life Insurance Companies | |

MBA headquarters is located at 1125 15th Street, N.W., Washington, D.C. 20005; telephone: (202) 861-6500.

and (3) a possible source of financing for abatement or mitigation actions that require a significant expenditure of funds. Thus, although our interests are less direct than managers who deal with tenants on a daily basis, we do deal with environmental concerns both at the time of transactions and where mitigation is necessary.

Consequently, we have an interest in the framework of indoor air legislation. MBA supports the thrust of HR 5373, but as discussed below has some particular concerns about the impact of this indoor air proposal on the public's perception of indoor air problems, and thus consumer demands on the real estate market.

We would also like to use this opportunity to correct any misconceptions the Subcommittee may have received during the hearing from the testimony presented and statement filed by the Building Owners and Managers Association. The Subcommittee may have been under the impression that the Building Owners and Managers Association was representing a coalition comprised of several of the real estate trade associations, including the Mortgage Bankers Association. MBA staff members have participated in several meetings involving some of the real estate groups, including the Building Owners and Managers Association, and co-signed recommended legislative proposals when S 1629, "the Indoor Air Quality Act", the companion legislation to HR 5373, was under consideration in the Senate Committee on Environment and Public Works. However, the Mortgage Bankers Association determines its own official policy positions on legislation and represents itself in that regard. Consequently, we hope that the Subcommittee continues to look to MBA for its legislative positions on specific legislative proposals developed in modifying HR 5373 in the Subcommittee.

HR 5373 THE INDOOR AIR QUALITY ACT

HR 5373, The Indoor Air Quality Act, represents a positive attempt to address a serious problem. The bill will encourage research on indoor air and contaminants and new approaches to indoor air problems.

MBA concurs with the research goals of the bill and, in fact, has already begun to make its own effort in that regard. In August of this year, MBA contributed

funds to an indoor air research project--a joint EPA/private sector study funded in the Department of Housing and Urban Development and Independent Agencies Appropriation Act for FY 1989 (P.L. 100-404). We hope that this study, designed to determine actual airborne exposure levels prevalent in buildings, to characterize peak exposure episodes, and to evaluate the effectiveness of asbestos management and abatement strategies will provide us with useful, practical information to help us all address asbestos problems in indoor air.

HR 5373 does recognize that there is a developing body of scientific and technical building expertise, but, as it is still evolving, achievement of standards could be difficult. Infant technology should not be overrun by precipitous legislative action. Consequently, MBA believes that directing EPA to provide guidance through such mechanisms as Indoor Air Health Advisories rather than through a regulatory program, is appropriate.

The Indoor Air bill will encourage new research and dissemination of new information. The technology management practice bulletins authorized by Section 5(d) of the bill, will help in particular to make that information available. HR 5373, as currently proposed, however, does not require that health advisories authorized under Section 6 of the bill contain technological information, and there is no link in timing between the health advisories and the technology management practice bulletins. Therefore, those who examine their properties for indoor air contaminants, will not, on the basis of the bill's health advisories, have the information available to consider appropriate mitigation or abatement actions at the time tests are conducted.

Consequently, MBA believes that legislation which takes a more comprehensive approach to the problems of indoor air may best meet the Subcommittee's goals.

We suggest that the Subcommittee consider an approach to indoor air which takes advantage of the fact that some technologies can achieve reduction in several pollutants simultaneously. Such an approach would provide information on health effects, but would shift the focus of the bill also to providing information on appropriate technologies. It would facilitate abatement and mitigation to have such information available.

In addition, while we support the thrust of HR 5373, we do, as noted below, have some concerns about the possible effect on the public, and thus on real estate transactions, of the issuance of health advisories prescribed in Section 6.

MBA is appreciative that the legislation has been revised from that originally introduced, and that health advisories will be available for public review and comment. We hope that the industry may be able to provide helpful comments on those health advisories based on its own experiences.

Nevertheless, we believe that these advisories will stimulate significant concern among the general public. However, development of indoor air technology to address that concern will occur more slowly. We are thus particularly concerned about the presentation of information in those health advisory materials, and the effect any shortage of technology and qualified personnel may have on safe and timely mitigation of hazards on which advisories will be issued.

Section 6 of HR 5373 directs the EPA to issue health advisories which: describe contaminants, identify the adverse human health effects and risks of the contaminants, identify the concentration of the contaminant at which no known or anticipated human health effect with an adequate margin of safety exists, and identify any indoor air contaminant standards. We are concerned that this "health effects" definition may be alarming, and ask the Committee to consider presenting the public with more information on abatement costs and comparable risks. We also suggest that the Subcommittee consider developing alternatives to the "anticipated human health effect with no adequate margin of safety" provision of the health advisory. Given the present market reaction to such environmental hazards, we hope that this information will be as detailed as possible, and that the health effects guidance will reflect technologically feasible goals.

The advisories should be developed with the intent to (1) inform the public fully of all the risks and costs of environmental indoor air hazards, and (2) assist the real estate community to be technologically capable of addressing the problem, and thus assuaging public concerns.

CURRENT REAL ESTATE EXPERIENCE

Our present perception of the potential effect of these advisories is affected by the real estate community's experiences with asbestos and radon, two of the substances for which EPA is expected to issue health advisories. As a result of current media presentation of the hazards associated with these contaminants, public reaction to the problems of asbestos and radon has not been entirely productive from either a public health or resource allocation perspective. Health advisories issued in accordance with the guidelines established in Section 6 would exacerbate present problems.

Asbestos Asbestos has been identified as a carcinogen for which EPA assumes that there is "no known safe level" in indoor air. Because of that EPA sanction, there has been a significant consumer, and consequently market, "reaction" to the presence of asbestos in public and commercial buildings.

However, despite the fact that EPA has specifically indicated that the appropriate response to nonfriable asbestos may be containment, market forces, e.g. tenant reluctance to inhabit spaces containing asbestos, often require that asbestos be removed from commercial space. Lenders and owners are presently uncertain whether removal or abatement is appropriate, despite the existence of EPA's Guidance for Containing Asbestos (the Purple Book) June 1985, and Federal standards under the Asbestos Hazard Emergency Response Act. Market demands for asbestos free buildings have been exacerbated by a shortage of qualified, competent personnel. For instance, in New York City, where much asbestos removal takes place in conjunction with renovation, substantial delays are presently being encountered, and asbestos removal costs approach \$50 per square foot. Because there is only one hazardous waste dump in New York which accepts asbestos, disposal problems are exacerbated. In fact, the Lincoln tunnel was closed twice due to asbestos dumping in the past year.

Under the present scheme described in Section 6 of the bill, an asbestos health advisory would state that there is no known safe level of asbestos, and would tend within the public perception to conflict with the EPA guidance document recommendations to contain nonfriable asbestos.

Radon MBA members had identified radon as a growing consumer and public health concern early this year. Until this fall, concern with radon hazards had been prominent in only certain areas of the country where radon was prevalent, e.g. in the areas surrounding the Reading prong and in Colorado. MBA was aware of selected instances where potential mortgagors had requested radon testing. Many of our members, as well as consumers, became familiar with the EPA Citizen's Guides to Radon, and Radon Reduction Methods A Homeowner's Guide."

In September of this year, Dr. Vernon J. Houk, Assistant Surgeon General of the Public Health Service issued a national advisory identifying radon as a national health problem and urging the testing of most homes in this country for radon. As a result of the substantial media coverage of this advisory, lenders are finding that consumers are inquiring about the presence of radon on a more frequent basis and are more likely to have homes tested for radon. In contrast to asbestos, consumers can test for the presence of radon on their own through use of such items as affordable charcoal canister kits, and mitigation can also frequently be conducted by the consumer. The availability of substantial knowledge and information on the risks of radon, provided in the EPA's Citizen's Guide and Radon Reduction Guide, in combination with the ease of consumer testing and mitigation, has served to produce, on the whole, productive consumer responses.

For radon, EPA's Guide presents a risk evaluation chart which shows the risks associated with exposure levels, as well as the risks associated with other causes of lung cancer, so that consumers may make informed choices as to their appropriate response. The Guide also provides useful information regarding the range of approaches that are recommended based on various levels of radon contamination, factors to consider, and appropriate authorities with which to consult in determining the appropriate response. Suggested action levels take into account factors such as technological feasibility and cost. In addition, the EPA booklet on Radon Reduction Methods for Homeowners also provides practical useful information for homeowners who do decide to mitigate. However, none of this information would be provided in a radon advisory issued under HR 5373.

CONCLUSION

MBA is finding that consumers are aware of the health hazards associated with exposure to contaminants, such as radon and asbestos, and are taking concrete actions to address the problems. However, we also recognize that in some instances we are encountering significant problems in attempting to address these hazards.

Thus, the Subcommittee should consider how these advisories will affect those concerns and needs, and, we suggest that the Subcommittee consider the radon model as a precedent for Indoor Air health advisories should they be included in the bill. We are encouraged that the Subcommittee is taking a deliberate approach to this serious problem, and look forward to working with the Subcommittee on further improvements to this legislation in the 101st Congress.

HEAL

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October 17, 1988

Congressman James H. Scheuer
Natural Resources, Agriculture Research
and Environment Subcommittee
U.S. House of Representatives
Washington, D.C. 20515

Dear Sir:

Thank you for the opportunity to provide written testimony on the Indoor Air Quality Act, H.R. 5575, for the House Subcommittee on Natural Resources, Agriculture Research and Environment.

Indoor contaminants pose a serious health threat to those with chemical and multiple chemical sensitivity disorders. The Indoor Air Quality Act includes a number of changes which reflect the health imperatives of those with this medical condition. These amendments were initially proposed by Baron B. Davis, J.D., M.P.H., Editor, ECOLOGICAL ILLNESS LAW REPORT, and Mary Lamielle, Chairperson, Environmental Resources Committee, Human Ecology Action League, and Director, Environmental Health Association of New Jersey, on behalf of a coalition of national, state and local organizations and individuals.

Indoor pollutants are a health risk to the entire U.S. population. EPA's TOTAL EXPOSURE ASSESSMENT METHODOLOGY (TEAM) STUDY, which analyzed the collage of toxics and carcinogens in the typical home environment, identified two chronic health effects from the elevated levels of volatile organics: CANCER and CHEMICAL SENSITIVITY. The TEAM STUDY described chemical sensitivity as a "condition marked by progressively more debilitating severe reactions to various consumer products such as perfumes, soaps, tobacco smoke, plastics, etc. The incidence of this syndrome is unknown; however, anecdotal accounts indicate that it may be increasing sharply. The effects on productivity of affected persons can be severe."

The Board on Environmental Studies and Toxicology of the National Research Council, National Academy of Sciences, estimates that approximately 15% of the U.S. population has "an increased allergic sensitivity to chemicals commonly found in household products, such as detergents, solvents, pesticides, metals and rubber, thus placing them at increased risk to disease." The Board recommended clinical studies to examine "hyperreactivity reactions."

The numbers of individuals impaired or disabled by the complex array of chemicals used in buildings, in furnishings and in consumer products is increasing dramatically. Pesticides, natural gas, formaldehyde, plastics, solvents and tobacco smoke are just a handful of the many substances which can cause debilitating reactions. Affected individuals may experience a kaleidoscope of mild to incapacitating symptoms from typical indoor exposures. Many of these individuals are precluded access to public and commercial buildings as well as the homes of family and friends due to the significant levels of chemical contaminants found in the average indoor environment.

Chemical and multiple chemical sensitivities--also known as ecological or environmental illness, environmental hypersensitivity, total allergy syndrome, maladaptation syndrome, the 20th century disease or CAIDS (Chemically Acquired Immune Deficiency Syndrome)--is a chronic condition in which a single, acute toxic exposure or chronic, low-level exposures to many substances result in apparent neurological and immune impairment. Subsequent contact with the initial contaminant and an increasingly wide range of related and unrelated synthetic and natural substances causes localized and systemic reactions.

Symptoms may vary from individual to individual and may depend on the trigger and the exposure method: inhalation, ingestion or skin absorption. Symptoms may include: fatigue, confusion, memory loss, seizures and additional neurological difficulties; muscle and joint pain and weakness; respiratory involvement including frequent bronchitis, asthma and hyperactive airway problems; gastrointestinal complaints with food intolerances; skin involvement such as rashes, hives, eczema and flushing; cardiovascular problems including vasculitis, hypertension and heart disease.

Over 50,000 chemicals are in daily use in the U.S. with approximately 1500 new ones introduced each year. Carpeting, adhesives, copy machines, wood veneers, pesticides and cleaning products are just some of the many office furnishings and supplies which emit volatile organic compounds (VOC's). While the volatile organic compounds typical to indoor environments have never been tested for individual, cumulative or synergistic effects, research has shown that (VOC's) can cause acute and chronic health effects.

Scientists at the Congressional Office of Technology Assessment have indicated that there is "increasing evidence that many chemicals have neurotoxic effects." Most solvents in everyday use have never been tested for neurotoxic and neurobehavioral effects. Solvents, nevertheless, are everywhere--in paints, adhesives, glues, dry cleaning fluids, office correction fluid and in cleaning and degreasing products. They are used in manufacturing toys, textiles, plastics and inks, among other products. Solvents are the "inerts" in most pesticides.

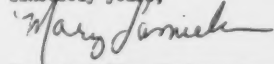
Dr. Mark R. Cullen of the Yale University Occupational Medicine Program and editor of *WORKERS WITH MULTIPLE CHEMICAL SENSITIVITIES* published in October 1987 by Hanley and Belfus, Inc. has evaluated individuals who have developed multiple chemical sensitivities from exposure to a polluted indoor atmosphere. Dr. Cullen notes that "indoor air pollution rivals organic solvents as the most common precipitant of this disturbance."

While the EPA has research under way to evaluate indoor pollutants, none of these projects focuses on chemical sensitivity disorders. There are currently no policies to control the mix of toxic and sensitizing substances present in the typical indoor area. There are no educational programs to avert potential casualties. There are no protections for those damaged by indoor pollutants.

In response to an inquiry from Baron G. Davis, Ms. Eileen Claussen, Director, Office of Program Development for EPA indicated that the agency's failure to focus on multiple chemical sensitivities/ecological illness is due in part to the "relative newness" and to the "very large dimensions of the problem" and to the "lack of legislation to deal with 'ecological illness' as a single problem." The Indoor Air Quality Act, H.R. 5373, is that opportunity to identify populations at significant risk of disabling health effects from exposures to environmental contaminants and to authorize action. One such population is those individuals with chemical and multiple chemical sensitivity disorders.

If you should require any additional information or if you should have any questions, please do not hesitate in contacting the undersigned.

Sincerely yours,



Mary Lamielle, Chairperson
Environmental Resources Committee
Human Ecology Action League;
Director,
Environmental Health Association
of New Jersey
1100 Rural Avenue
Voorhees, New Jersey 08043
(609)429-5358

HENRY J. NOWAK
33rd District, New York

COMMITTEES:
PUBLIC WORKS AND
TRANSPORTATION

CHAIRMAN:
SUBCOMMITTEE ON WATER
RESOURCES

SCIENCE, SPACE, AND
TECHNOLOGY

Congress of the United States
House of Representatives
Washington, DC 20515

WASHINGTON OFFICE
2240 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 226-3309

DISTRICT OFFICE:
U.S. COURTHOUSE
Room 212
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(716) 863-4121

January 24, 1989

Hon. James H. Scheuer
Chairman
Science Space & Technology Subcommittee
on Natural Resources, Agricultural Research
and Environment
H-2-388
HOB Annex 2
Washington, D.C. 20515

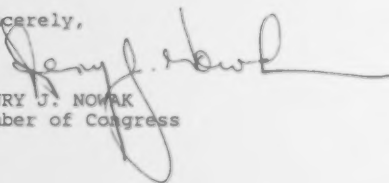
Dear Mr. Chairman:

I have enclosed for your information correspondence from
a constituent concerned about the human health threats of
indoor contaminants.

It is my understanding that the subcommittee will be
reconsidering the Indoor Air Quality Act this Congress,
therefore, I am submitting this information for the record.

Best Wishes,

Sincerely,


HENRY J. NOWAK
Member of Congress

ENVIRONMENTAL MEDICINE
PEDIATRIC ALLERGY

DORIS J. RAPP, M.D., F.C.
(716) 878-8578

DORIS J. RAPP, M.D., F.A.A.A., F.A.A.P.
1421 COLVIN BOULEVARD
BUFFALO, NEW YORK 14223

December 15, 1988

Congressman Henry J. Nowak
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Nowak:

There is a bill in the 100th Congress now that is entitled H.R. 5373, which aims to reduce the threat of human health posed by exposure to indoor contaminants. As a physician, I would like to urge you strongly, to consider implementation of this proposed bill.

This past week, I saw an infant who was well until 8 days of age when they placed synthetic carpet that contained 23 chemicals in their home. Within 24 hours, the mother was sick, the infant was sick, and a four year old sibling was ill. This family is still ill. The carpet has now been removed, but because of the massive exposure, these three members in this family now have problems if they are exposed to the slightest amount of perfume, tobacco, or other common chemical odors. This is a well-recognized problem after a massive chemical exposure, namely, it is called the "spreading factor" and it means minute amounts of innumerable chemicals appear to cause varying degrees of symptoms after a single massive exposure to one chemical.

Another infant in my practice was exposed to pesticides and cleaning solutions when he was being carried in the uterus because his mother worked as a cleaning lady. He then was exposed afterwards. He is so exquisitely sensitive to chemicals now, that when his mother took him to Los Angeles, they just got off the plane and the one year old baby started to scream and dig at his skin and say that it hurt. This happened every time he was outside in Los Angeles over a period of a couple of days. He was originally exposed and sensitized to indoor pollution and it now appears that outdoor pollution is a major problem with this infant.

In Canada, they have clean classrooms that are not chemically contaminated. In this country, most people are not even aware that these chemicals can incapacitate children and adults. I sincerely hope that you will give this bill serious consideration and pass it. If you want more details about any aspect of this or these patients that I have mentioned, please do not hesitate to contact me.

Most sincerely,

Doris J. Rapp, M.D.

Doris J. Rapp, M.D.
F.A.A.A. F.A.A.P.
Clin. Asst. Prof. of Ped. at SUNYAB

DJR:anf



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

December 15, 1988

OFFICE OF
THE ADMINISTRATOR

Honorable James H. Scheuer
Chairman
Subcommittee on Natural Resources,
Agriculture Research and Environment
Committee on Science, Space, and
Technology
House of Representatives
Washington, DC 20515

RE: Report on the EPA Indoor
Air Quality Implementation Plan

Dear Congressman Scheuer:

I am pleased to transmit via this letter the report of the Science Advisory Board's (SAB) Indoor Air Quality and Total Human Exposure Committee (IAQTHE) on its review of the "EPA Indoor Air Quality Implementation Plan" as required under Section 403(d) of Title IV of the Superfund Amendments and Reauthorization Act of 1987 (P.L. 99-499). This same report is also being transmitted to the Administrator of the U.S. Environmental Protection Agency under separate cover.

The Committee found the Implementation Plan and its Appendices to be useful and well done. It is clear that the Agency has identified in a rather comprehensive manner the level of our knowledge concerning indoor air pollution.

The major conclusions and recommendations of the Committee concerning the Implementation Plan include the need for: development of criteria for establishing research priorities; a full time Director with expertise, authority, and direction to set-up an adequate program; adequate funding to support an effective indoor air quality program; coordination of research with other agencies; increasing the role of research on the sick building syndrome (SBS) and on building related illnesses (BRI); more emphasis on strategic planning to address both long and short term goals; and, wide dissemination of EPA's research findings.

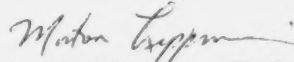
A further report on this issue will be forwarded to you following the Committee's review of the report to Congress being prepared under Section 403(e) of the Act. This review is planned for early 1989.

Report to Congress on EPA's Indoor
Air Quality Implementation Plan

Page 2

The Committee appreciates this opportunity to review and present our views on the Agency's Indoor Air Quality Implementation Plan.

Sincerely,



Morton Lippmann, Ph.D.
Chairman
Indoor Air Quality and Total
Human Exposure Committee
Science Advisory Board

Copies furnished to:

Honorable Glenn Anderson
Chairman
Committee on Public Works
and Transportation
House of Representatives
Washington, DC 20515

Honorable Edward P. Boland
Chairman
Subcommittee on HUD-Independent
Agencies
Committee on Appropriations
House of Representatives
Washington, DC 20515

Honorable John H. Chafee
Ranking Minority Member
Subcommittee on Environmental
Protection
Committee on Environment and
Public Works
United States Senate
Washington, DC 20510

Honorable John D. Dingell
Chairman
Committee on Energy and Commerce
House of Representatives
Washington, DC 20515

Honorable Jake Garn
Ranking Minority Member
Subcommittee on HUD-Independent
Agencies
Committee on Appropriations
United States Senate
Washington, DC 20510

Honorable Bill Green
Ranking Minority Member
Subcommittee on HUD-Independent
Agencies
Committee on Appropriations
House of Representatives
Washington, DC 20515

-2-

Honorable John Paul Hammerschmidt
Ranking Minority Member
Committee on Public Works and
Transportation
House of Representatives
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Honorable Frank R. Lautenberg
Chairman
Subcommittee on Superfund and
Environmental Oversight
Committee on Environment and
Public Works
United States Senate
Washington, DC 20510

Honorable Norman F. Lent
Ranking Minority Member
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House of Representatives
Washington, DC 20515

Honorable Manuel Lujan, Jr.
Ranking Minority Member
Committee on Science, Space,
and Technology
House of Representatives
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Honorable Edward R. Madigan
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Honorable George J. Mitchell
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Honorable Henry J. Nowak
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Subcommittee on Water Resources
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House of Representatives
Washington, DC 20515

Honorable William Proxmire
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Subcommittee on HUD-Independent
Agencies
Committee on Appropriations
United States Senate
Washington, DC 20510

Honorable Robert A. Roe
Chairman
Committee on Science, Space,
and Technology
House of Representatives
Washington, DC 20515

Honorable James H. Scheuer
Chairman
Subcommittee on Natural Resources,
Agriculture Research and Environment
Committee on Science, Space, and
Technology
House of Representatives
Washington, DC 20515

Honorable Claudine Schneider
Ranking Minority Member
Subcommittee on Natural Resources,
Agriculture Research and Environment
Committee on Science, Space, and
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House of Representatives
Washington, DC 20515

Honorable Robert T. Stafford
Ranking Minority Member
Committee on Environment and
Public Works
United States Senate
Washington, DC 20510

Honorable Arlan Stangeland
Ranking Minority Member
Subcommittee on Water Resources
Committee on Public Works and
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Honorable John W. Warner
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Environmental Oversight
Committee on Environment and
Public Works
United States Senate
Washington, DC 20510

Honorable Henry A. Waxman
Chairman
Subcommittee on Health and
the Environment
Committee on Energy and Commerce
House of Representatives
Washington, DC 20515

United States
Environmental Protection
Agency

Office of the Administrator
Science Advisory Board
Washington, DC 20460

EPA-SAB/IAQTHE-89-010
December 1988



EPA

Report of the Indoor Air Quality/Total Human Exposure Committee (IAQTHE)

Review of the EPA Indoor Air Quality Implementation Plan



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

December 15, 1988

The Honorable Lee. M. Thomas
Administrator
U.S. Environmental Protection
Agency
401 M Street, S.W.
Washington, DC 20460

OFFICE OF
THE ADMINISTRATOR

RE: Report on the EPA Indoor
Air Quality Implementation
Plan

Dear Mr. Thomas:

I am pleased to transmit via this letter the final report of the Science Advisory Board's (SAB) Indoor Air Quality and Total Human Exposure Committee (IAQTHE) on its review of the "EPA Indoor Air Quality Implementation Plan" as required under Sections 403(c) and (d) of Title IV of the Superfund Amendments and Reauthorization Act of 1987 (P.L. 99-499). This same report is also being transmitted to the Congress under separate cover as required under Section 403(d) of the Act.

The Committee found the Implementation Plan and its Appendices to be useful and well done. It is clear that the Agency has identified in a rather comprehensive manner the level of our knowledge concerning indoor air pollution. Nevertheless, the Committee was concerned that recommendations of earlier SAB review panels who provided advice on the total human exposure program in 1985 and the indoor air program in 1986 have not been addressed, particularly with regard to program management and strategic planning. These earlier recommendations and how they relate to the present review are discussed in the attached report.

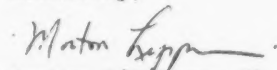
The major conclusions and recommendations of the Committee concerning the Implementation Plan include the need for: development of criteria for establishing research priorities; a full time Director with expertise, authority, and direction to set-up an adequate program; adequate funding to support an effective indoor air quality program; coordination of research with other agencies; increasing the role of research on the sick building syndrome (SBS) and building related illnesses (BRI); more emphasis on strategic planning to address both long and short term goals; and, wide dissemination of EPA's research findings.

Letter to Mr. Thomas

Page 2

The Committee appreciates this opportunity to review and present our views on the Agency's Indoor Air Quality Implementation Plan.

Sincerely,



Morton Lippmann, Ph.D.
Chairman

Indoor Air Quality and Total
Human Exposure Committee

cc: Don Barnes
Erich Bretthauer
Eileen Claussen
Don Clay
Ray Loehr

THE SCIENCE ADVISORY BOARD
INDOOR AIR QUALITY AND TOTAL HUMAN EXPOSURE
COMMITTEE

REPORT ON THE

INDOOR AIR QUALITY IMPLEMENTATION PLAN

(As required by Section 403(d) of the Radon Gas
and Indoor Air Quality Research Act of 1986)

December 15, 1988

SCIENCE ADVISORY BOARD
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC

ABSTRACT

Under the provisions of Title IV of the Superfund Amendments and Reauthorization Act of 1987 (P.L. 99-499), the Science Advisory Board of the U.S. Environmental Protection Agency has established the Indoor Air Quality/Total Human Exposure Committee (IAQTHE) to review the Agency's Indoor Air Quality Implementation Plan and to provide continuing advice to the Administrator on indoor air issues. This is the Committee's first report, reflecting its views on the Implementation Plan forwarded to the Congress in 1987. The Committee's major recommendations include the need for: criteria for establishing research priorities; a full-time Director with expertise, authority, and direction to set-up an adequate program; adequate funding to support an effective indoor air quality program; coordination of research with other agencies; increasing the role of research on the sick building syndrome and building related illnesses; more emphasis on strategic planning to address both long and short term goals; and wide dissemination of EPA's research findings.

Key Words: Indoor Air Quality, Radon

U.S. Environmental Protection Agency

NOTICE

This report has been written as part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency; and, hence, the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency or other agencies in the Federal Government. Mention of trade names or commercial products do not constitute a recommendation for use.

U.S. ENVIRONMENTAL PROTECTION AGENCY
SCIENCE ADVISORY BOARD
WASHINGTON, D.C.
Indoor Air Quality/Total Human Exposure Committee

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Ms. Carolyn Osborne, Staff Secretary, Science Advisory Board (A-101F), U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC

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APPENDICES

- A. Specific Comments on the Implementation Plan and its Appendices.
- B. Report of the Radiation Advisory Committee to the Indoor Air Quality and Total Human Exposure Committee

1.0 EXECUTIVE SUMMARY

The Indoor Air Quality and Total Human Exposure Committee of the U.S. Environmental Protection Agency's Science Advisory Board (SAB) was established under Section 403(c) of the Radon Gas and Indoor Air Quality Research Act of 1986.¹ This first report of the Committee concerns its review of the "EPA Indoor Air Quality Implementation Plan" (EPA/600/8-87/031, June 1987).

In general, the Committee found the Implementation Plan and its associated appendices to be useful and largely correct. The Agency has completed a fairly comprehensive review of the level of our knowledge concerning indoor air pollution and has identified numerous research needs. Nevertheless, some of the earlier recommendations concerning indoor air quality made by Science Advisory Board panels have not been addressed, particularly with regard to program management and strategic planning. These are discussed in the body of this report. Based on its review of the Implementation Plan, the Committee has reached the following major conclusions and recommendations.

a) The EPA must set-up criteria for establishing indoor air quality research priorities. Suggested issues include: identification of research gaps best addressed by additional human clinical and epidemiological studies, improved methods for estimating population risk to indoor air pollutants, development of a welfare component, and the possible contributions of other agencies in research efforts not traditional for EPA such as psychosocial research.

b) A full-time Director with specific expertise in indoor air quality is needed with adequate authority and direction to develop a research program in indoor air quality.

c) Adequate funding is needed. The present and proposed budgets are clearly insufficient to support an effective indoor air quality research program.

d) EPA should coordinate its own research program with research done at other agencies (especially within the Interagency Committee on Indoor Air Quality (CIAQ)).

e) The Sick Building Syndrome (SBS) and Building Related Illnesses (BRI) are increasingly being recognized as major components of the indoor air quality issue, and should have larger roles in the existing research effort.

¹ Title IV of the Superfund Amendments and Reauthorization Act of 1987 (P.L. 99-499).

f) The research program must be developed with more emphasis on strategic planning in order to address short and long term goals.

g) EPA should insure that its indoor air research findings, after appropriate external review, are widely disseminated, especially to the public, and that these findings help form the basis for public policy decisions.

2.0 INTRODUCTION

2.1 Background

In passing the Radon and Indoor Air Quality Research Act of 1986, Congress formalized its recognition of the serious health implications of exposure to radon gas and other indoor air pollutants, and acknowledged its concern that existing Federal research into these pollutants was fragmented and underfunded.

Sections 403(a) and (b) of the Act directed the Administrator of the U.S. Environmental Protection Agency to establish a research program to address these pollutants. The research program was to be designed to include: data acquisition in order to better understand the health implications of radon gas and other indoor air pollutants; coordination of Federal, state, local, and private research and development; and assessment of Federal Government actions to mitigate environmental and health risks associated with indoor air problems. The Administrator was further directed to prepare a plan to implement the research program and to submit this plan to Congress. The preliminary implementation plan was submitted to Congress in April 1987, with the revised and expanded version submitted in July 1987.

Section 403(c) directed the Administrator to establish an advisory committee made up of representatives from the States, the scientific community, industry, and public interest organizations to assist him in carrying out the research program. This statutory advisory committee was formed under the Agency's Science Advisory Board as the Indoor Air Quality and Total Human Exposure Committee (IAQTHE).²

This Committee first met on November 19-20, 1987 to review the Implementation Plan, obtain program briefings from Agency staff, and to provide preliminary advice to the Agency concerning the research program. Since the Implementation Plan had already been submitted to Congress at the time the Committee conducted its review, recommendations concerning the Plan were provided

² The Committee has also been charged by the Science Advisory Board with the responsibility for reviewing and providing advice on the Agency's Total Human Exposure Research Program.

orally at the meeting with individual written comments provided by Committee members following the meeting. Initially, the Committee planned to submit its comments to Congress on the Implementation Plan after the Committee completed its review of the report required under Section 403(e) of the Act. Since this latter report has not been made available for Committee review, it is not now possible to complete the Committee review until early 1989, therefore, the Committee has finalized its recommendations concerning the Implementation Plan in the interim in this report.

2.2 Charge to the Committee

Under the provisions of Sections 403(c) and (d) of the Radon Gas and Indoor Air Quality Act of 1986, the Committee has been charged with the following responsibilities:

a) To assist the Administrator in carrying out the research program for radon gas and indoor air quality [Section 403(c)].

b) Review the plan for implementation of the research program on indoor air quality and submit its comments on the plan to Congress [Section 403(d)].

The Committee has taken this charge broadly. Under Section 403(e) of the Act, the Administrator must submit a report to Congress which details his activities under Section 403, making recommendations as appropriate. At its November 19-20, 1987 meeting, the Committee provided the Agency with its comments regarding the preliminary outline of this report. Although not specifically mandated to review this particular document, the Committee recommended that under the provisions of Section 403(c), the Agency provide them with the opportunity to review the report and make appropriate suggestions prior to its submission to Congress. The Committee asked for the opportunity to review this report prior to its submission to Congress.

The Committee views its charge to include providing continuing scientific advice to both the Administrator and the Congress, as appropriate.

2.3 Previous Recommendations by Science Advisory Board Committees and Panels

On September 3-4, 1986, the SAB's Indoor Air Quality Research Review Panel publically reviewed the Agency's indoor air quality research program as part of the SAB's continuing series of research reviews designed to examine the research programs of the Agency's Office of Research and Development (ORD). The purpose of these reviews was to provide the EPA Administrator and the Assistant Administrator of ORD with insight as to their research programs. Specifically, the SAB reviews were to identify whether research was being done in a scientifically sound manner, and whether the research was appropriately targeted

to regulatory needs of the Agency. The present Committee (IAQTHE) is, in part, a successor to that earlier research review panel. With many of the former members serving on the present Committee an excellent link to previous SAB experience and deliberations concerning indoor air quality has been established.

The Indoor Air Quality Research Review Panel reached a number of pertinent conclusions that are appropriate to mention here since they are closely tied to the efforts of the present Committee. Their major conclusions include the following:

- a) The Agency should develop and adopt a clear policy statement that indoor air quality is an important and essential part of its responsibility. This statement should clearly define the policy and program goals toward which the research is directed.
- b) Responsibility for the indoor air quality program should be assigned to an individual of strong, proven leadership who has appropriate scientific stature and specific experience in this area, who would devote full time attention to this program and to the implementation of a research needs assessment.
- c) An effective indoor air quality program must be multi-disciplinary with clearly recognizable goals.
- d) The Agency should carefully articulate how it plans to integrate work carried out by other public agencies and private organizations into its own research program.

It appears that although much progress has been made, some of the previous concerns of the SAB have yet to be fully addressed. Through its implementation plan and supporting documents EPA has articulated policy objectives for its approach to characterize and understand human health risks from exposure to pollutions in indoor environments. Nevertheless, a strong program of research must emerge, not just a collection of competent research that is not always linked together.

The Agency has attempted to provide sound leadership for its indoor air research efforts, but still has not identified a single, well qualified individual to lead the program. The several managers who have been shepherding the program thus far are capable and are doing commendable jobs, however, the program would be better served by a full-time manager who is not splitting time with other major responsibilities.

Efforts have been made to provide adequate interdisciplinary links within the Agency to foster indoor air research. Nevertheless, a stronger programmatic strategy is needed to focus it. Such a strategy is only now coming about. Interagency coordination has developed considerably since the previous review, with member agencies of the CIAQ participating more, and with the EPA representative to that group being a senior manager in the indoor air program area within EPA.

2.4 Format of this Report

This report links earlier activities of the Science Advisory Board to the present effort in reviewing indoor air quality research programs. This report contains three sections which are: Policy Objectives and Research Strategies, Program Management and Coordination, and General Comments on the Implementation Plan. Detailed, specific comments from several Committee members concerning the reviewed documents are contained in Appendix A.

Since the SAB has a permanent standing committee on radiation - the Radiation Advisory Committee (RAC) - it decided that the RAC should perform the review of the radon gas portion of the Implementation Plan and provide its comments to the IAQTHE Committee. Three members of the RAC were appointed to serve on the IAQTHE Committee to provide a bridge. The general comments and conclusions of the RAC have been integrated into the present report, however, their complete report is included as Appendix B.

This report constitutes the formal report of the Science Advisory Board's Indoor Air Quality and Total Human Exposure Committee to Congress and to the Administrator of the U.S. Environmental Protection Agency on its review of the Agency's Indoor Air Quality Implementation Plan as required by Section 403(d) of the Radon Gas and Indoor Air Quality Research Act of 1986.

3.0 POLICY OBJECTIVES AND RESEARCH STRATEGIES

Although not specifically charged with responsibility to regulate indoor air pollutants, EPA is still the Federal agency for which indoor air quality is closest to its central mission. The Agency does regulate some indoor air pollutants through other means. For example, household pesticides are regulated under the Federal Insecticide, Fungicide and Rodenticide Act, and toxic chemicals under the Toxic Substances Control Act. While this creates some degree of control over indoor pollutants, it is not an integrated approach to the problem. The ability to enforce regulation of indoor exposures is severely limited by physical, fiscal, and political constraints. Therefore, alternatives such as education and licensing (or authorization or certification) of those responsible for providing indoor air quality should also be considered.

4.0 PROGRAM MANAGEMENT AND COORDINATION

4.1 Internal Management

The U.S. Environmental Protection Agency has completed a fairly comprehensive review of the status of our knowledge of indoor air pollution, identifying a number of research needs

along the way. In order for it to meet its stated policy objectives, it is crucial for the Agency to establish research priorities and design a research strategy which will address short and long term goals. The current research program is one of default, i.e., it was constructed from already existing lines of research. There are few clear directions for the future in the existing program. Although many of the ongoing research projects address important indoor air quality problems, there are also instances in which projects or components of projects are rather peripheral and/or repeat work which has already been done.

It is critical to the success of the indoor air quality program that the Agency appoint a full-time Director for the program with specific expertise in indoor air quality and that he or she be given adequate authority and control of budget to establish research priorities, and to design and implement a strong research program. The fact that the Agency has not yet designated a single director suggests a half-hearted commitment to a program which Congress clearly views as important. Because of the limited resources which will be available to this program over the next few years, this Director must also be able to effectively collaborate with other agencies through the CIAQ in order to stretch resources to meet stated goals. Although a single, senior Director is needed to focus the indoor air quality program, we must compliment the current managers for having accomplished as much as they have with such a fragmented and poorly supported effort.

4.2 Interagency Coordination

It is likely that some of the research being performed at other agencies can help to meet national and EPA research needs. Good communications and relations between agencies will be essential in this effort. It would be desirable if other members of the CIAQ provided a listing of indoor air quality research projects for each of their agencies, much like EPA has done in Appendix B of the June 1987 Implementation Plan. This would be useful to EPA in avoiding duplication of research efforts.

4.3 Budgetary Constraints

The EPA indoor air quality budget is simply inadequate to meet the needs of the program as stated by the Agency, even with its present narrow focus. This is a problem that can be traced to inadequate funding from Congress as well as a less than aggressive approach from EPA in seeking expanded funding. For example, in FY88 the budget allocated to the Office of Research and Development was \$2.3 million, with an additional \$0.3 million going to the Office of Air and Radiation. This issue requires further attention from both Congress and EPA.

A possible mechanism of funding that has not been sufficiently utilized is the EPA's Extramural Exploratory Research Grants Program. For FY 88 and FY 89, this program has about an \$8 million budget, reduced from about \$11 million in

FY87. This represents a significant reduction from the 1981 figure of nearly \$30 million (calculated in constant 1988 dollars). The Grants program is very useful for funding the more risky long-term and exploratory research that is difficult for the Agency to carry out internally or through cooperative agreements. A major strength of the program is that it is a peer-reviewed process. If the Congress provides increased funding to the Extramural Exploratory Research Grants Program directed towards Indoor Air Quality this would provide a strong stimulus towards innovative research in this area.

5.0 GENERAL COMMENTS ON THE IMPLEMENTATION PLAN

5.1 Radon Gas

From the perspective of radon research, we believe the Implementation Plan is satisfactory. However, we are concerned with recent information regarding the status of the National Radon Survey, which is included as part of the plan and which has been specifically mandated by Congress. At the fall 1988 meeting of the SAB's Radiation Advisory Committee (RAC), it was noted that funding for the National Radon Survey has been eliminated in the budget plan for FY 1989. We can understand that faced with limited funds and unlimited demand, it might be decided that this relatively expensive project should be deferred or even cancelled all together. We find this troublesome, however, since without this authoritative survey, it is going to be very difficult to decide how to attack the indoor radon problem. It is certainly recognized that risk from radon in indoor air ranks highly among total airborne constituents known to be present in most buildings.

We believe that it is essential to obtain a reasonable quantitative estimate on the magnitude of the indoor air radon problem. This step can best be taken with the proposed National Radon Survey. It is therefore strongly recommended that this survey be supported and carried out as soon as possible.

Further detailed comments are contained in the report of the Radiation Advisory Committee to the IAQTHE Committee - See Appendix B. Individual comments from Dr. Samet concerning radon are included in Appendix A (see pages A-4 through A-6).

5.2 Other Indoor Pollutants

The balance of concern is still biased heavily toward residential environments rather than a dual approach that also considers commercial and public sector/public access buildings. We were surprised that the document contained no risk assessments, and the report claimed that risk assessments for populations are not presently possible. Although we agree that such assessments are difficult, they are not impossible as suggested by EPA's Scoping Study on Indoor Air Quality (prepared

by the Office of Program Development (OPD) of the Office of Air and Radiation) which contains a substantial effort to do such assessments. The reader of the two documents is left uncertain if OPD and ORD are communicating with one another.

5.3 Sick Building Syndrome and Building Related Illnesses

Although the sick building syndrome (SBS) and building related illnesses (BRI) are two of the most important aspects of the indoor air quality problem, they were essentially left unaddressed in the document, playing minor roles in the research effort. The importance of SBS for the productivity and well-being of workers in non-industrial environments mandates a high priority. There should be a thorough discussion of the sick building syndrome and its symptoms, building related illnesses and their clinical signs, the multi-factorial nature of the causes of SBS (including psychosocial parameters), the methodology used to study SBS and BRI, and the present inadequate state of knowledge of these manifestations.

5.4 Workshop on Strategy

The lack of a more coherent strategy may be due, at least in part, to the fact that EPA did not fully address the recommendations of the 1986 SAB Indoor Air Quality Research Review Panel. Whatever the reasons, it is important that EPA develop a strategic plan for its research effort. In the document, EPA points out that additional workshops will be held to improve the document. If additional workshops are to be held, we strongly recommend that the next one address the improvement of the research strategy. The Committee is willing to assist EPA in developing such a workshop and is willing to have its members participate in it.

The major goal of the workshop would be to develop an overall strategy for establishing indoor air quality research priorities. Topics that should be addressed include: methods for estimating population risk to indoor air pollutants; identification of research gaps in the present program; the identification and role of research not traditionally carried out by EPA, such as the SBS, biological and psychosocial research; methods for setting research priorities using the above information; and the role of other agencies in funding such research.

APPENDIX A
SPECIFIC COMMENTS ON THE IMPLEMENTATION PLAN
AND ITS APPENDICIES

Dr. Joan Daisey	A-1
Mr. Seymour Jablon	A-3
Dr. Vic Laties	A-3
Dr. Jon Samet	A-4
Dr. Jerome Wesolowski	A-6

COMMENTS FROM DR. JOAN DAISEYAppendix A:

p. 1-7: Some relative risk estimation is feasible at present, e.g., radon, VOC.

p. 2-5, Table 2-1: This type of information can be helpful in establishing research priorities. The figure of 4% of the population exposed to gas phase organics, in the table, is ridiculous. The TEAM (Total Exposure Assessment Methodology) study as well as others have demonstrated that this figure is more like 100%!

p. 2-29: The last sentences of paragraph 2 and 3 contradict each other.

p. 2-110ff: The whole issue of samplers for VOC needs a critical look. Sampler development must be well integrated with overall EPA research objectives. The canister sampler has been very strongly pushed for VOC despite the success of the adsorbent sampling method used for the TEAM study. The canister samplers were originally designed to take grab samples in remote locations where levels are low. They are very bulky to handle and ship and require expensive controls in order to be used to obtain an integrated sample. The Tenax adsorbent sampler also has some limitations with respect to the compounds which it can collect. However, there are commercially available multi-sorbent samplers which can be used to extend the range of compounds sampled. The multi-sorbent sampler has been used at LBL (Lawrence Berkeley Laboratory) for indoor air studies and shown to have very high accuracy and precision. It is quite feasible to develop sorbent samplers for more reactive and/or polar compounds for use in field studies. Project 13 in the Research Program (Appendix B) is an Assessment of Screening (Sampling, presumably) Techniques for Indoor Air Pollutants. A very critical look at the cost-effectiveness of the various sampling devices available, their specific applications, the need for each application and at their acceptability to the public since they must be used in homes, buildings, etc., is needed. It is not clear why a field test is needed in this project since most of the devices mentioned have already been widely used in the field.

Appendix B:

Project 14 - Why are there plans to develop a method for nicotine? Dr. Hammond has developed a very good sampling and analysis method for this compound.

Project 15 - Are there plans to couple a micro-processor with the realtime NO₂ monitor?

Project 19 - Why do work on urine mutagenicity when urine cotinine is a much more specific marker? Furthermore, it has been shown in a number of studies that urine mutagenicity reflects dietary influences as well as exposure to tobacco smoke.

Project 28 - Based on the information provided, the necessity of this project is not clear. The stated purpose is to develop a method for measuring air exchange rates that is more accurate, less expensive and easier to use. There is no indication of what this might be. The testing of already widely tested and used methods will not provide a new method.

Project 33 - The Project Director should be made aware that CPSC (Consumer Product Safety Commission) has funded some research on this at LBL and that the results of the work will be available in early 1988. This information may be useful in planning future experiments.

Both Projects 32 and 33 mention developing new/improved design concepts. Some may feel that this type of activity belongs more in private industry than in EPA.

Preliminary Outline of the Report to Congress on Indoor Air Quality

VOLUME II

Section II. Is this the Organization of the Program? It would be useful to have a organization diagram included with the names of key personnel.

Section IV.A. A section on Research Strategy and Establishment of Research Priorities should be added after Policy Development.

Section IV.C. A section on CIAQ, its nature and function, should be included here.

VOLUME III

Will the Agency be assessing absolute or relative risks or both?

VOLUME IV

Section I. The basis for establishing research priorities must be discussed. The outline as written gives no indication of the relative priorities for the research needs; it is merely a list.

Section I. Under research needs and relative priorities, some discussion of EPA collaboration with other agencies would be appropriate.

Section I.A.2.a. The strategy for this needs to be discussed.
 Section I.B. Item number 1 should be "Scope of the Problem."

COMMENTS FROM MR. SEYMOUR JABLON

Implementation Plan:

Page 5: The very first item under the general heading of 'Indoor Air Policy Objectives and Strategy' refers to the intent to "...refine its assessment of the nature and magnitude of the health ... problems posed by individual air pollutants...". This general intention is specified with respect to radon on page 15 of Appendix C. 'EPA Radon Program.' There, the first item under the heading 'Radon Exposure and Health Risk' is: "Conduct a National Assessment of Representative Structure Types and Geographical Locations."

The EPA clearly realizes that the data presently available concerning the distribution of radon levels in residences, workplaces, schools and other public buildings is inadequate: there are available surveys in particular places, often relying on volunteers, using a variety of measurement devices. Something like ten percent of the housing stock of the country may exceed the recommended guideline of 4 pCi/l for radon. As the experience with the Reading Prong made plain, there can be large areas where, unsuspected, residents may be exposed to high, and dangerous, levels of radon. The proposed assessment is, therefore, not only highly desirable but needed urgently. In the face of this need, which is recognized by EPA, it is disturbing to learn that despite the fact that the proposed survey has been in the planning and review process for years, there are no funds in the FY 88 budget for the survey. I would point out that the Plan, as reported to the Congress, is apparently not supported by the intention to act, at least not this year. I regard this as very unfortunate, to say the least.

Preliminary Outline:

To my untutored eye, the Outline seems quite thorough and complete. I presume that the Radon Measurement Proficiency Program would come under Volume II, Iv., B., 1. "Radon Exposure and Health Risks". This is an important program, especially since it seems quite possible that EPA will one day be mandated to certify organizations that offer measurement services and having this program in place, with the kinks worked out, will be very helpful.

COMMENTS FROM DR. VIC LATIES

Implementation Plan: Objectives and Strategy Section (pgs 5-7):

1. The section seems too focussed upon EPA's own intramural activities. Nowhere does it recognize efforts within the

environmental health sciences by other parts of the Agency itself or by other parts of the Federal government. For instance take the first point: "The Agency will conduct research and analysis to further refine its assessment...." This statement, coupled with the appendix outlining what intramural work is being done, pays no attention to EPA's Extramural Exploratory Research Grants and Centers program, which can support research at universities on questions of interest to EPA. I have been sensitized to the role of that effort by service on one of its study sections and think that EPA gives it too little support. This report ignores its role in generating the interest of the larger university community in problems associated with indoor air quality. EPA's intramural scientists however worthy simply can't solve all the many problems in this vast area by themselves.

2. Emphasis on improving exposure data and on modeling seems excessive to me. These are important topics but our knowledge of health effects remains weak for many of the substances important for indoor air quality. No other agency has either the enduring interest in air quality or the in-house expertise to run a program in that area. EPA should support research on the health effects of air quality. If it does not, the whole area is likely to wither away.

COMMENTS FROM DR. JON SAMET

With regard to the "EPA Indoor Air Quality Implementation Plan", I have only brief comments to offer. I concur with the overall objectives, but have some concerns about the approach that will be taken to meet the first objective, "Problem Characterization." The strategies listed are largely directed at describing the overall extent of the indoor air quality problem, largely by combining a description of exposures with risk assessment methodology. Does this strategy represent the appropriate basis for problem-solving or merely provide more elegant descriptions of problems that we already know about? We need strategies for identifying those individuals placed at high risk by their individual exposures; without this capability, interventions to reduce health effects will be unsoundly based.

I see the work scopes described under "Problem Characterization" as not appropriately balanced between studies of exposure and of health effects. Inevitably, a risk projection model will indicate health effects for many exposures that are likely to be measured in U.S. homes. However, these risk assessments will be subject to substantial uncertainty unless appropriate laboratory, clinical, and epidemiological studies are planned and performed.

With regard to Appendix C "EPA Radon Program," I think that the Committee should have access to materials that are mentioned in the document to fully understand the current radon program. The

Committee should review the methodology for assisting states in conducting radon surveys as well as educational materials for the public and for the "Radon Diagnostician" training course. I recognize that the SAB has had involvement with the national radon survey; nevertheless, I would suggest review of materials related to this project as well. Likely of necessity, the description of the radon program is brief, and I think that our Committee needs access to the background documents that I have mentioned.

I agree with the overall goals as described on page 12 of Appendix C. In the face of the extensive evidence on lung cancer already available, the immediate goals must be reduction of exposure in existing homes and the development of strategies to prevent problems in new homes. I am also in agreement with the strategy, as outlined on page 13, and the broad structure of the implementation plan, as outlined on pages 14 and 15. However, I do have comments about specific items within the indoor radon program.

With regard to the proposed national survey, the overall goal of describing exposure in the United States is appropriate. However, if the survey tells us little about the determinants of levels in homes, what will be gained beyond a description of exposure, presumably followed by a risk assessment, that will ultimately document a known hazard? While we do not have data from a soundly based nationwide sample, several data bases, including those reported by Nero and by the Terradex Corporation have provided substantial insight into the distribution of levels. It seems unlikely that the findings in a nationwide sample will be strikingly different from the information already available.

It would be most unfortunate if the national survey were not used to answer important questions related to the determinants of levels in homes. Consideration should be given to using the sample as the basis for more detailed studies, perhaps directed at homes with higher and lower levels. Geology and house characteristics, such as ventilation rate, might be assessed for a more limited sample of homes. A scientific basis for predicting concentrations in individual homes is badly needed for the purpose of mitigation.

I would like to learn more about the state surveys that are being conducted. Have standard methods been developed that are used by all the states? How are the samples obtained? Will the data be merged and analyzed centrally at EPA? Data collected by the states could be quite informative, but might also be misleading if proper sampling procedures have not been followed nor careful quality assurance programs maintained.

Similarly, are measurements made by commercial firms reported to EPA? If not, could EPA consider obtaining such measurements, perhaps as a requirement for certification. The resulting data

base could become quite useful for describing the higher end of the distribution of radon levels.

The introduction to the document on page 12 confuses the concept of attributable risk. For exposures that interact synergistically, such as radon progeny and cigarette smoking, attributable risk estimates may add to greater than 100%. This property of the attributable risk statistic means that even though 85% of all lung cancer deaths are attributed to smoking by the Surgeon General, more than 15% could be attributed to radon. The proportion of lung cancer deaths attributable to radon should not be considered to be the ratio of 5,000 to 20,000, estimated for radon, to the total of approximately 130,000 lung cancer deaths per year.

I have also reviewed the few pages in Appendix A concerning radon. The material on health effects and dosimetry is brief and misleading in some respects. If the document is revised in the future, I would suggest an improved discussion of dosimetry, and inclusion of certain key references in place of those that are used in the present document. The discussion of factors described as influencing radiation dosage to the lung is confused and incorrect in some respects.

COMMENTS FROM DR. JEROME WESOLOWSKI

Appendix A - The Assessment:

General Comments:

In general I found the report contained useful and mostly correct information. However, considering that this is not the first draft, there was a surprising amount of incorrect information. In fact, parts of the report appear to have been written by staff unfamiliar with the field. I trust the following comments will help improve the report.

I was surprised that the report contained no risk assessments and that the authors explicitly state (p.1-141 that ...risk estimates for populations are not presently possible. Although I would agree that risk estimates for populations are very difficult I do not understand why EPA's ORD thinks they are not possible when the Scoping Study on IAQ recently prepared in draft form by OPD of EPA contains a substantial effort at doing just that. For example, there is a table in the Scoping Study of estimated individual lifetime excess cancer risks of volatile organic compounds and pesticides. Perhaps the ORD authors are trying to say that the total risk due to all pollutants cannot be estimated. Nevertheless the reader of these two documents is left with the impression that ORD and OPD have different views on the efficacy of IAQ risk assessment. The two offices should work more closely in the preparation of IAQ documents so that such fundamental differences can be resolved.

Although the so-called Sick Building Syndrome (SBS) is one of the most important aspects of the IAQ problem, it was essentially left unaddressed in this document. There should be a thorough discussion of the Syndrome, the symptoms, the multi factorial nature of the causes (including psychosocial parameters), the methodology used to study SBS, and the present inadequate state of knowledge of this problem. Although there is a short Chapter on "Building Systems" (which may have been intended to address the SBS) it was rather superficial, incomplete, and did not address the above stated issues.

Although the authors state that EPA is adopting a "dual" approach to IAQ (cf. p.1-4), viz. sources and building types, the report neglects to discuss building types (the "Building System" chapter makes no mention of types). I don't believe the authors really mean EPA will address the IAQ problem by studying building types (although such a categorization is useful), but rather that studying individual sources is not sufficient but must be complimented with studies of the multi-factorial causes associated with buildings and building systems. They say something similar to this on p.1-4. However the report is heavily weighted towards individual sources. Thus, it does not in fact reflect a dual approach. Again this could be remedied by a thorough discussion on SBS and by improving the "Building Systems" Chapter.

In general the report is a useful start in assessing current IAQ information, but unless the weaknesses described above are addressed it will be of limited value, and in fact could be misleading enough to make intelligent choices for research priorities difficult.

Specific Comments:

p.1-7. Although "Estimation of health hazards from specific indoor situations or sources may be more useful than trying to derive risk estimates ..." (after all many inhabitants are not really interested in specific risk numbers). However risk estimates are still needed in order to establish research priorities for the Agency.

p.1-7. Dividing combustion products into combustion gases, combustion particles, and combustion organics could be confusing. For example, formaldehyde is a combustion gas, a noncombustion gas, a combustion organic, and a non-combustion organic. To demonstrate this possible confusion I note the awkward sentence on p. 2-123, "One noncombustion gas-phase organic compound is formaldehyde which is also a product of combustion". A better definition might be "Combustion products can be divided into inorganic gases, principally nitrogen dioxide, carbon monoxide and sulfur dioxide, particles, and organic compounds, including PAH and formaldehyde".

p. 1-7 Par.3, 1st sentence. Insert the article "as" before "an 8-hour day".

p. 1-8. The section on carbon monoxide should record that approximately 1,000 persons die accidentally each year in the United States of carbon monoxide poisoning, about 800 from motor vehicle exhaust and 200 from incomplete combustion of domestic fuels. This does not include about 300 who die in industrial accidents. And it should be noted that this death rate is not based on fragile epidemiological associations, but on actual mortality records. (It also does not include those who die of accidents caused by CO-induced mental impairment.)

p. 1-11. The first two sentences of the first paragraph are not complete.

p. 1-10. The sentence "Only some of these organics have been identified, fewer have been quantified" should be changed to read "Only some of these organic compounds have been identified, fewer compound's emissions have been quantified", since organic is an adjective not a noun.

p. 1-10. Should "One to 3 ng/m³" be "One to 3 ng" or "should 20 to 50 ng" be "20 to 50 ng/m³"?

p.1-10. The statement "It's primary source ... is ETS..." needs a reference since some believe that poorly adjusted unvented combustion appliances contribute to far larger concentrations than does ETS.

p. 1-11. Calling noncombustion gas-phase organics VOCs is indeed a misnomer. But scientists do not usually make this mistake. Why does this report imply that it is common? Organic compounds have been classified as VVOC--very volatile (or gaseous) organic compounds with boiling points from: 0 to 50-100 degrees C; VOC--volatile organic compounds with boiling points from 50-100 to 240-260 degrees C; SVOC--semi-volatile organic compounds with boiling points from 210-260 to 380-400 degrees C; and POM-- organic compounds associated with particulate matter with boiling points >380 degrees C. For the most part, these groups are operationally defined by the manner in which they are collected. The so-called misnomer is caused by the clumsy terminology coined by this report, noncombustion gas-phase organics.

p. 1-11. The Danish studies referred to did not demonstrate that 5 to 25 milligrams per cubic meter caused synergistic behavioral changes. The work simply concluded that "Healthy persons with indoor climatic complaints react acutely to both 5 and 25 milligrams per cubic meter of a mixture of typical indoor climate pollutants." At no point did they claim that this demonstrated synergistic effects.

p. 1-11. According to Molhave, the particular organic compounds and the concentrations of these compounds are based upon residential indoor air not the air in office buildings.

p. 1-11. "However, no health effects data is available... should be "data are".

p. 1-11. Despite the statement that exposures to organic compounds cannot be estimated at this time, WHO believes that an estimate of exposure to many organic compounds is possible and has done so in a draft report that is currently being reviewed.

p. 1-12. "The extent of exposure (to formaldehyde) in environments other than mobile homes has not been estimated" is incorrect. SAI in a study funded by the Calif. Air Resources Board has measured the formaldehyde concentration distribution in typical California housing (as reported in the 1983 National Consensus Workshop for Formaldehyde in Little Rock, AR), and LBL in a study funded by BPA measured the concentration distribution in 40 office buildings in the Pacific-Northwest (as reported at an APCA national meeting).

p. 1-12. Radon is also actively monitored.

p. 1-13. The statement "Since they are organic substances, primarily in the vapor phase" is incorrect and contradicts the statement that they are SVOC in the same sentence. SVOC have boiling points ranging from 210-260 to 380-400 degrees C. Compounds with such high boiling points will not exist primarily in the vapor phase.

p. 1-15. Table 1-1 indicates that there are no CO active samplers for use indoors. GE manufactured a small active sampler for use indoors. This is the sampler used for EPA's Denver and Washington studies. This sampler is described in detail on p. 1-19 of this report. Further, this table seems to be making a distinction between passive samplers used for area sampling and samplers used as personal exposure monitors (PEM). For the most part this is a distinction in use not in the actual monitor, in that a monitor suitable for area monitoring often could be used as a PEM. e.g.. a Track-Etch radon detector could be worn as a PEM.

p. 2-1. The authors state "...individual pollutants from such a source are measured and correlated with source presence or use, but other emission components are not measured." What is meant by other emission components? If the authors mean not all pollutants from a source have their emissions quantified, they should say that.

p. 2-4. The authors state "...and usually the emission, of a very complex mixture of organic and inorganic gaseous and particulate pollutants. In addition, the complex mixture that results from incomplete combustion can contain a variety of other volatile and semivolatile, polar and nonpolar chemical products." The use of the word "other" notwithstanding, the second sentence merely repeats the message of the first.

p. 1-12. The authors should refrain from using such mass-media jargon as "formaldehyde is a suspected actor in the sick building syndrome." Further, why single out formaldehyde as one of the factors in SBS?

p. 1-18. There are typographical errors in the last three columns of the E.T.S. section of the Table.

p. 2-1. Again, one doesn't normally refer to noncombustion and combustion particles but rather to particles and combustion-generated particles. Likewise one does not normally refer to noncombustion gas-phase organic compounds but to organic compounds and combustion-generated organic compounds.

p. 2-2. The authors bring out the important difference between exposure, concentration and dose. However, they use two expressions for exposure, viz. "nominal exposure" and "exposure." They never state the difference between exposure and nominal exposure.

p. 2-4. The authors state the lower tail of distribution can identify especially sensitive populations." It is not clear how an exposure distribution will identify who is sensitive in the population.

p. 2-4. The authors state risk estimates for populations exposed to indoor air pollutants are therefore premature." Refer to an earlier general comment on this issue.

p. 2-41. The section on Sulfur Dioxide is structured differently than those on Carbon Monoxide and Nitrogen Dioxide, specifically exposure and conclusions are missing, as well as the opening paragraph describing the compound. Furthermore, the first paragraph on monitoring discusses particulate matter, not sulfur dioxide.

p. 2-6. Nitrogen dioxide and sulfur dioxide are indeed products of complete combustion, certainly not of incomplete combustion.

p. 2-8. I suspect that the statement that most American homes use natural gas and that most do not vent the combustion products outdoors is in error. It likely true for gas ranges and ovens but is not true for water heaters, wall space heaters and furnaces. A reference is needed.

p. 2-9. The GEOMET Technologies, Inc. reference that burner design does not influence emissions is out of date. Research by the Gas Research Institute has produced a burner design that appears to reduce NO₂ emissions. Research by LBL for the US CPSC showed substantial differences in NO₂ emissions for unvented gas-fired space heaters even after adjustment for heat output which was attributed to differences in burner design.

p. 2-9. Last paragraph: 500 and 600 hours should be 500 and 600 homes.

p. 2-14. Traynor conducted a study measuring the emissions of NO , NO_2 , CO , and CO_2 from several wood stoves. This study should be referenced.

p. 2-16. "The absence of reliable emission factors from the indoor sources makes it impossible to establish a relative ranking between.." This statement is simply not true. The emission rates illustrated in Table 2-6 vary for well known reasons: 1) the rates listed are for appliances with different combustion rates, e.g., the emission rates for the gas space heaters were obtained from heaters whose inputs ranged from 12,000 BTU/H to 40,000 BTU/H, and 2) contrary to the statement on p. 2-9 burner design does affect emission rates. Moschandreas has conducted and reported upon an extensive study of the various test methods and showed that the various methods generally gave comparable results within the experimental errors produced by state-of-the-art instrumentation.

p. 2-17. What are the authors referring to as unburned benzene hydrocarbons? What is a benzene hydrocarbon? How is it different from benzene? Do they mean aromatic hydrocarbons? Are they referring to PAH? If so, strictly speaking, they probably should not be referred to as unburned since they are formed in flames and are in a sense combustion generated.

p. 2-17. Emission rates from combustion appliances are well known with the exception of SVOC. It has not been demonstrated that these are produced in sufficient quantity to warrant extensive study to obtain these rates.

p. 2-26. In contrast to what is implied, cigarettes are a minor source of NO_2 . One could not measure the rise in NO_2 in a room where a cigarette is smoked (see for example, Good, Environ. Int. 8, 1982).

p. 2-29. Systems designed for monitoring NO_2 in ambient air have been employed to monitor it in indoor environments in many studies. Improvements would be very welcome but it is not true that the systems are too large and complex to be used indoors. It's been done frequently.

p. 2-30. It is unlikely that NO_2 is absorbed by materials: it is adsorbed. In addition, there are studies which have quantitated this effect for various materials. These results and references should be added to this report.

p. 2-31. How do you "roughly assume"?

p. 2-41. The authors have offered no proof that, NO_2 is likely to have either an additive or synergistic effects with other

indoor pollutants." In fact, the statement contradicts the one on p.2-31 which states "Thus we have no significant knowledge of additivity, synergism, or antagonism associated with NO₂ in mixtures with other combustion products, much less with the full range of indoor air chemicals."

p. 2-110. The discussion regarding the variation of emission rates from adhesives is somewhat naive, indicates a lack of knowledge of the studies in the Table, and the authors implication that there is a right answer is incorrect. Certainly temperature is important. For "wet" building materials such as adhesives the age of the material is very important. The relative humidity may be important for certain products because of the specific chemistry involved, e.g., formaldehyde from urea-formaldehyde remains because of hydrolysis; product loading may also be important for products which contain the chemical as a bulk constituent, e.g., again formaldehyde in urea-formaldehyde resins and p-dichlorobenzene in moth crystals; air exchange rate, per se, is probably not important but the local velocity of the air stream near the boundary layer may be very important. Unfortunately the report misses the major surprise of Table 2-23: the rates listed are amazingly similar when one considers that 1) the ages of the adhesives range from 0.5 h to 14 days; 2) the chamber volumes ranged from 3.8 L to 1000 L; 3) air exchange rates varied from 0.04 h⁻¹ to 14 h⁻¹; and most importantly, 4) it is highly probable that none of the researchers were testing the same adhesive from the same manufacturer with the same formulation. Why would anyone expect to measure the same emission rate from different products? Presumably some of the adhesives even came from different continents. One of the major points of the study cited which examined 15 different adhesives (Girman et al., 1984b) was that there were large variations in organic emissions from different adhesives, even those with the same nominal application (and this from a study that used the same methodology in determining rates so that the comparison should be valid).

p. 2-42. The authors state that "...particulate matter consists of liquids, aerosols or solid particles ...". Aerosols are not a type of particulate matter. An aerosol is a gas system with solid and/or liquid particles dispersed in it.

p. 2-47. The reference to Sexton and Repetto (1982) concerning the mutagenic density for cooking stoves and cigarette smoke is incorrect. The correct reference is Sexton et al., 1984.

p. 2-50. The authors state that human exposures to inhalable particulate ... probably has increased due to concentrations of fine aerosols or ultra-fine particulates generated within homes and offices." What is the evidence for this increase?

p.2-61. Change PNA to PAH.

p.2-63. The authors state that "... nonpolar fraction...only accounts for about one-third of the mutagenicity...". Because one-third is larger than usually reported, a reference here is important.

p.2-64. The last sentence of 2.3.7 and the first of 2.3.7.1 are almost identical.

p.2-64, Sec. 2.3.7.1 In their article, Pandey, et.al. did not say the dwellings were "unventilated" but only "illventilated" cf. (p.414 of Vol. 4 of Stockholm conference).

p.2-122. A more recent paper on the "Bake-Out" procedure is: Girman, J., Alevantis, L., Kulasingham, G., Petreas, and Webber, L.(1987) "A Bake-Out of an Office Building" proceedings of the 4th International Conference on Indoor Air Quality and Climate, Berlin.

Table 2-39. A more recent paper which demonstrated irritant effects to be associated with HCHO exposure in a state-wide random survey of mobile homes is: Liu, Kai-Shen; Huang, Fan-Yen; Hayward, S.B., and Wesolowski, J.J. (1987). "Irritant Effects of Formaldehyde In Mobile Homes", proceedings of the 4th International Conference on Indoor Air Quality and Climate, Berlin.

p. 2-95. Top of page -It might be worth noting that the amphiboles are also more resistant to acid than is chrysotile. This is especially true of crocidolite.

p. 2-95. One of the more important uses of asbestos has been in spray-on fireproofing and acoustical insulation.

p. 2-96. Many of the studies mentioned in this report measured concentrations of airborne asbestos in ng/m³. Such measurements involve the use of indirect preparation, including ashing and sonic dispersion. This means that the results are not interpretable in terms of fiber concentration or fiber size. In most of these studies this is not a serious flaw, as long as fairly high concentrations are detected. However, the Sebastien study on floor tile should have been repeated using direct methods. This is because it is not clear how much the fibers were bound in a vinyl matrix, which would have been oxidized and removed by ashing. Thus fibers might have been counted which may or may not have been biologically relevant.

p. 2-97. Top of page- Most fibers are not too short to be detected in the optical microscope. They are simply too thin.

p. 2-97. Bottom - Chrysotile identification by morphology is not enough. Electron diffraction is required for positive identification.

p. 2-99. The relationship $300 \text{ ng/m}^3 = 10,000 \text{ fibers/m}^3$ seems rather high. A reference is needed. Our work would indicate that $10,000 \text{ fibers/m}^3$ usually equals approximately 0.1 to 1 ng/m^3 .

p. 2-103. A discussion of asbestos in homes would be appropriate.

p. 2-130. Polonium 214 decays to lead-210 with a half-life of 164 microseconds, rather than 22 years. It is lead-210 that has a half-life of 22 years.

p. 2-131. The text states that radon decay products are very small particles which agglomerate rapidly and readily attach to surfaces. Of course atoms can be considered particles in the wave-particle quality sense. However, it would be more informative just to say that the decay product atoms are solids at room temperature, so that when they are produced by the decay of the radon gas atoms, they readily agglomerate or attach to surfaces.

p. 2-131. Bottom of the page- The lower limit of detection for radon in air is listed as 500 pCi/m^3 (0.5 pCi/l). Since the report lists levels measured in outdoor air which are lower than 500 pCi/m^3 , this is clearly not a lower limit of detection for some methods. Even for methods typically used in indoor air, lower limits of detection are commonly achieved using longer integration times.

p. 2-132. Bottom of the page- "The radon is released from the water at elevated temperatures, and when the water is..." should read "Radon release from the water increases as the water temperature increases, or when the water is..."

p. 2-134. How could comparison to the National Ambient Air Quality Standard for particulate matter be illuminating in any way?

p. 2-137, 2-138. It does not make sense to state that the link between a given air concentration of radon and the consequent radiation dosage involves the ratio of indoor radon levels to outdoor levels.

p. 2-146, second to last sentence. "Typo on knowledge".

p. 2-146. This section should briefly discuss the measurement units that are often used, viz., cfm/m^3 . The previous section should discuss typical values found, as well as the generally accepted "consensus" standard of about 1000 cfm/m^3 .

p. 2-163. The authors state that "Biologically relevant exposures to electric and magnetic fields ... are widespread." They give no definition of "biologically relevant". If, as I suspect, they are referring to health endpoints studied in the

various experiments discussed subsequently, then they should change the word "are" to "may" since, as the authors themselves state (p.2-167), "There are data consistent with a possible (my emphasis) connection between exposure....".

p.4-1. Odors is discussed in the welfare section. It would be interesting to state why here instead of in the health section, say under a comfort heading.

p.4-22. First paragraph, second sentence. Delete "in" ?

p.5-1, last sentence of introduction. Insert the word "to" before "a source...".

p.5-11. The authors state that "...the problems are caused by a mixture of pollutants and by the interaction of these mixtures with the building system." Although this may be true in many cases, there are others where the problem is caused by a single parameter. e.g. excess CO. Further, the interaction can be with more than just the system, e.g. it can be with psychological, psychosocial factors, etc.

p.5-1. It is not clear what the difference is between two of the six categories, "building system source and sink effects" and "effects of sources and sinks". Further, an important research need is missing, viz. research in areas such as psychological, psychosocial, mass hysteria, etc. Occupants and their behavior can be considered part of the building "system". Although these are difficult research areas, the SBS problem will never be fully understood unless they are taken into account. The author's lack of discussion of these topics in this document is conspicuous.

Appendix E-References

This is a useful reference base. It would be much more useful if it could also be categorized according to subject matter. I would also recommend a clear statement on the first page indicating where abstracts and papers could be sent by authors in order to minimize emissions in subsequent updates. It also would be very useful if this data base could be put on floppies (in ASCII) and made available on request to authors and researchers in IAQ.

APPENDIX B

REPORT OF THE RADIATION ADVISORY COMMITTEE
TO THE
INDOOR AIR QUALITY AND TOTAL HUMAN EXPOSURE
COMMITTEE

RAC

Radiological Assessments Corporation

November 13, 1987

Dr. Morton Lippmann, Chairman
Indoor Air Quality/Total Human Exposure Subcommittee
Science Advisory Board
U.S. Environmental Protection Agency
Room 1145 W, Waterside Mall
401 M Street SW
Washington, D.C. 20460

Dear Dr. Lippmann:

The Radiation Advisory Committee has reviewed the "EPA Indoor Air Quality Implementation Plan-A Report to Congress Under Title IV of the Superfund Amendments and Reauthorization Act of 1986:Radon Gas and Indoor Air Quality Research." In order to keep in mind the objectives of the Report to Congress, I have restated Congressional expectations as they were presented to us earlier this summer

"...The Report is to describe the state of knowledge concerning risks to human health of indoor air pollutants; the locations and amounts of indoor air pollutants in structures through the country; existing standards for indoor air pollutants suggested by Federal and State governments or scientific organizations and the risk to health associated with such standards; research needs and the relative priority of these needs; and the effectiveness of possible government actions to mitigate health risks associated with indoor air quality problems."

The Committee kept this charge in mind as we performed our review. It is noted, however, that we focused on those sections dealing with radon (the main report and Appendix C). Our comments are summarized in the information that follows.

Radiological Assessments Corporation

General Comments

In general, the plan is satisfactory and should meet the expectations of Congress. The summary should be carefully edited and Appendix C should be updated to include recent data that have been published on radon.

The Committee is concerned, however, with recent information regarding the status of the National Radon Survey, which is included as a part of the plan and which has been specifically mandated by Congress. It was pointed out to the Committee at its last meeting, that funding for the National Radon Survey has been eliminated in the budget plan for FY 1988. The Committee can understand that faced with limited funds and unlimited demand, it might be decided that this relatively expensive project should be deferred or even cancelled all together. We find this troublesome, however, since without this authoritative survey, it is going to be very difficult to decide how to attack the indoor radon problem. It is certainly recognized that risk from radon in indoor air ranks highly among total airborne constituents known to be present in most buildings.

As one of its responsibilities recently, the Radiation Advisory Committee established a Subcommittee to review Agency plans for the National Radon survey. Consequently, the Committee made recommendations for what is considered a scientifically satisfactory study for the frequency distribution of radon exposures nationwide. The study might not answer all questions raised about factors influencing the radon levels, since it was realized that some of these answers would require a much larger study. Nevertheless, the National Survey would answer key questions related to radon in indoor air and assist greatly in putting exposure to radon and progeny in better perspective.

The Committee believes that it is essential to obtain a reasonable fix on the magnitude of the indoor air radon problem. This step can best be taken with the proposed National Survey on radon. It is therefore strongly recommended that this survey be supported and carried out as soon as possible.

Specific Comments on the Report to Congress

Summary

Page 1

The summary deals with generalities and lacks specific tangibles. The Committee believes that Congress will find it difficult to understand what is being proposed as a plan based on the summary alone.

Effective summaries are difficult to write, of course, but this one could have been much more specific about the general types of pollutants to be looked and how the relative importance of each will be addressed. As it is currently written, the summary does not do justice to the rest of the document.

As a minor point, HUD is not mentioned here. It's role is given on page 21 and the planned coordination with HUD throughout seems much less than we would have expected, given that HUD has been involved in substantial research in this area and presumably has a continuing interest, especially, as specifications for new houses are involved.

Pages 7-10, Activities and Accomplishments to Date

This section contains a lot of specifics and is generally good and informative. However, there is nothing here at all about progress that EPA has already made on radon. More information should be included here on what has been accomplished to date.

Pages 10-17, Near Term Implementation Plan

This section is also good where it is specific, however, much of the material contains generalities. Again there is nothing presented on radon and a cross reference to Appendix C as a minimum would be helpful. Note that in the table on page 24 under radon in the right hand column on health effects, the end product should not be "cancer" which implies cancer in general, but "lung cancer" since this is the only type of cancer which radon induces.

Appendix C

Since pages 1-11 are missing, the reader might wonder why these pages were omitted. As a minimum, some statement about their content and why they were not included should be added.

page 12, lines 1-4

It is true that radon comes from radium but the radium comes from uranium, and it is the distribution of uranium in soil that begins the decay chain. We recommend adding to the first sentence "...and is itself a decay product of uranium."

page 14, Implementation Plan

We recommend separating radon exposure and health risk since they are quite distinct and health risk deserves its own bullet.

page 17, (d)

This section points to a highly desirable need to ensure sound measurement methods. However, it also brings up the question of how all the measurements made by commercial firms could be utilized. For example, for epidemiological purposes, for contributing to our knowledge of a national average background level, etc. Perhaps such firms could be required to publish their results or submit them to EPA in a form that would make them useful.

page 17, (e)

Health risks should have its own section and the information could be expanded. Reviewing the miner studies is still an important thing to do and information on them keeps accruing. This fact is somewhat buried in the last paragraph.

page 18, paragraph 1

Isn't NCI (Boice) also conducting or collaborating in some studies in New Jersey, Stockholm, and China?

page 18, paragraph 2

The BEIR IV Report being referred to as published in 1987 has not yet been released.

page 19, paragraph 1

Among these four mitigation techniques there is no discussion of number two, ventilation, throughout pages 19-21 even though it is noted that simple basement exhaust fans are very effective in some circumstances. In general, it appears that this section could be expanded based on the recent work by OEET.

page 20

It seems that greater involvement with HUD could have been expected in (c) and (d).

page 24, Public Information

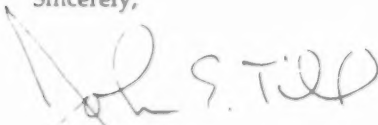
EPA deserves credit for getting something done here. The brochures produced by the Agency are very good.

page 25, line 1

"A copy of DOE's Radon Research Program Plan is attached as Appendix E." The plan is not attached. Appendix E is a bibliography.

We hope these comments will be helpful in your review. Please contact me if we can be of further assistance.

Sincerely,



John E. Till, Ph.D.
~~Acting~~ Chairman

copy to: Members, Radiation Advisory Committee

Radiological Assessments Corporation

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